Cardio Menu

Operator Manual

Cardiovit AT-5 ECG Unit

Service Handbook

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AT-5 Service Handbook

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Associated Documents

Guide to SCHILLER Interpretation and Measurement Program E / D / F	Article No.	2. 510 179
SCHILLER AT-5 USER GUIDE - English	Article No.	2. 510 143
SCHILLER AT-5 USER GUIDE - German	Article No.	2. 510 142
SCHILLER AT-5 USER GUIDE - French	Article No.	2. 510 144

CE 0124 93/42/EEC Medical Devices: 0124
'Notified Body' DEKRA AG

DECLARATION OF CONFORMITY

Diagnostic System :	**Cardiovit AT-5**
Serial numbers starting with:	040.
Year of manufacture:	1997 Onwards

We, the undersigned, hereby declare that the medical device (class IIa) specified above conforms with the essential requirement listed in Annex 1 of EC Directive 93/42/EEC.

This declaration is supported by:

Certificate of approval No.:	11425-01	ISO 9001 (REv. 1994) EN 46001 by SQS
	45112-60-01	ISO 9001/08.94 EN 46001 / 12.93 by DEKRA and
	45112-16-01	Annex II, Section 3 of the directive 93/42/EEC

CE 0124

Baar (Switzerland) Dated 30.06.1998

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Warranty

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Terms of Warranty

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The manufacturer can only be held responsible for the safety, reliability, and performance of the apparatus if:

° assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by him, and

° the unit and approved attached equipment is used in accordance with the manufacturers instructions.

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Safety Notices

TO PREVENT ELECTRIC SHOCK DO NOT DISASSEMBLE THE UNIT. NO SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL ONLY.

DO NOT USE THIS UNIT IN AREAS WHERE THERE IS ANY DANGER OF EXPLOSION OR THE PRESENCE OF FLAMMABLE GASES SUCH AS ANAESTHETIC AGENTS.

IF THE DISPLAY IS DAMAGED, A LEAKAGE OF FLUID MAY OCCUR. DO NOT INHALE THE VAPOUR FROM THIS FLUID AND AVOID CONTACT WITH MOUTH AND SKIN. IF CONTACT IS MADE, CLEAN CONTAMINATED AREA IMMEDIATELY WITH FRESH WATER.

THIS PRODUCT IS NOT DESIGNED FOR STERILE USE.

SWITCH THE UNIT OFF BEFORE CLEANING AND DISCONNECT FROM THE MAINS.

DO NOT, UNDER ANY CIRCUMSTANCES, IMMERSE THE UNIT OR CABLE ASSEMBLIES IN LIQUID.

DO NOT OPERATE THE UNIT IF THE EARTH CONNECTION IS SUSPECT OR IF THE MAINS LEAD IS DAMAGED OR SUSPECTED OF BEING DAMAGED.

DO NOT USE HIGH TEMPERATURE STERILISATION PROCESSES (SUCH AS AUTOCLAVING). DO NOT USE E-BEAM OR GAMMA RADIATION STERILISATION.

DO NOT USE SOLVENT CLEANERS

USE ONLY ACCESSORIES AND OTHER PARTS RECOMMENDED OR SUPPLIED BY SCHILLER AG. USE OF OTHER THAN RECOMMENDED OR SUPPLIED PARTS MAY RESULT IN INJURY INACCURATE INFORMATION AND/ OR DAMAGE TO THE UNIT.

THE AT-5 COMPLIES WITH EMC REGULATIONS FOR MEDICAL PRODUCTS WHICH AFFORDS PROTECTION AGAINST EMISSIONS AND ELECTRICAL INTERFERENCE. HOWEVER SPECIAL CARE MUST BE EXERCISED WHEN THE AT-5 IS USED WITH HIGH FREQUENCY EQUIPMENT.

IT MUST BE ENSURED THAT NEITHER THE PATIENT NOR THE ELECTRODES (INCLUDING THE NEUTRAL ELECTRODE) COME INTO CONTACT WITH OTHER PERSONS OR CONDUCTING OBJECTS (EVEN IF THESE ARE EARTHED).

THERE IS NO DANGER WHEN USING THE ECG UNIT FOR A PACEMAKER PATIENT OR WITH SIMULTANEOUS USE OF OTHER ELECTRICAL STIMULATION EQUIPMENT. HOWEVER, THE STIMULATION UNITS SHOULD ONLY BE USED AT A SUFFICIENT DISTANCE FROM THE ELECTRODES. IN CASE OF DOUBT, THE PATIENT SHOULD BE DISCONNECTED FROM THE RECORDER.

THIS UNIT IS CF CLASSIFIED ACCORDING TO IEC 601-1. THIS MEANS THAT THE PATIENT CONNECTION IS FULLY ISOLATED AND DEFIBRILLATION PROTECTED. SCHILLER CAN ONLY GUARANTEE PROTECTION AGAINST DEFIBRILLATION VOLTAGE, HOWEVER, WHEN THE ORIGINAL SCHILLER PATIENT CABLE IS USED.

Safety Notices

BEFORE USING THE UNIT, ENSURE THAT AN INTRODUCTION REGARDING THE UNIT FUNCTIONS AND THE SAFETY PRECAUTIONS HAS BEEN PROVIDED BY A SCHILLER REPRESENTATIVE.

THE GUIDELINES FOR PATIENT ELECTRODE PLACEMENT ARE PROVIDED AS ON OVERVIEW ONLY. THEY ARE NOT A SUBSTITUTE FOR MEDICAL EXPERTISE.

THE AT-5 ECG UNIT IS PROVIDED FOR THE EXCLUSIVE USE OF QUALIFIED PHYSICIANS OR PERSONNEL UNDER THEIR DIRECT SUPERVISION. THE NUMERICAL AND GRAPHICAL RESULTS AND ANY INTERPRETATION DERIVED FROM A RECORDING MUST BE EXAMINED WITH RESPECT TO THE PATIENTS OVERALL CLINICAL CONDITION. THE RECORDING PREPARATION QUALITY AND THE GENERAL RECORDED DATA QUALITY, WHICH COULD EFFECT THE REPORT DATA ACCURACY, MUST ALSO BE TAKEN INTO ACCOUNT.

IT IS THE PHYSICIANS RESPONSIBILITY TO MAKE THE DIAGNOSIS OR TO OBTAIN EXPERT OPINION ON THE RESULTS, AND TO INSTITUTE CORRECT TREATMENT IF INDICATED.

What´s in this Book

THE SERVICE PHILOSOPHY FOR ALL SCHILLER UNITS IS FAULT FINDING TO MODULE LEVEL. THE PURPOSE OF THIS BOOK IS TO PROVIDE ALL THE INFORMATION NECESSARY TO ENABLE THE SERVICE ENGINEER TO EFFICIENTLY LOCATE AND REPLACE A FAULTY MODULE. THIS BOOK ASSUMES NO DETAILED KNOWLEDGE OF THE AT-5 BUT DOES REQUIRE THAT THE SERVICE ENGINEER IS FAMILIAR WITH STANDARD WORKSHOP PRACTICES.

The book is divided into the following chapters:

Chapter 1 - Operating Elements

The purpose of this chapter is to provide an easy reference for all the main operator functions and to give a basic introduction to the AT-5. This chapter gives details of the operator controls with the operation and function of each key briefly explained. The information in this chapter provides a background to the operating functions only. Complete operating information is provided in the SCHILLER AT-5 Operating Manual.

Chapter 2 - Functional Description

This chapter provides a functional overview of the AT-5 The functional description is supported by functional block diagrams.

Chapter 3 - Fault Diagnosis

This chapter provides a guide to locate a fault to module level. The diagnostics are presented in a logical sequence of fault finding algorithms and procedures. Illustrations are provided to support the text where needed.

Chapter 4 - Physical Overview & Module Replacement

This chapter gives an overview of the physical construction of the AT-5 with the main physical attributes of the unit briefly described. The physical description is supported by illustrations showing the internal location of all modules. Removal and Replacement instructions for all replaceable modules are also provided in this chapter. Each procedure is autonomous with details of tools, jumper settings, adjustments, and settings or special requirements that are required before and after replacement. Functional checks that must be carried out after replacing a new module are also provided.

Chapter 5 - Functional Checks & Adjustments

This chapter provides all adjustments and settings. Also detailed in this chapter are basic functional test procedures that can be performed to check the functioning of the unit.

Chapter 6 - Spare Parts

This Chapter provides the part numbers and reordering information for all replaceable modules. Also included in this chapter are details of any special test equipment or special tools required for adjustment or fault finding procedures.

Chapter 7 - Technical Data

The full technical specification of the AT-5 is given in this chapter.

What's in this Book

Chapter 8 - Glossary

This Chapter explains all the acronyms and signal titles used in this book and in the AT-5 circuit diagrams.

Annex A - Circuit Diagrams & Board layouts

The circuit diagrams and component layouts are provided for all boards. These details are provided for information only.

We Need Your Help

The philosophy of SCHILLER is one of continuous improvement. Our aim is to provide the user with the most up-to-date information and the latest technological developments. We reserve the right to revise this document and make changes or improvements at any time.

Your suggestions and comments are welcome. Please contact the SCHILLER Technical Documentation Department:

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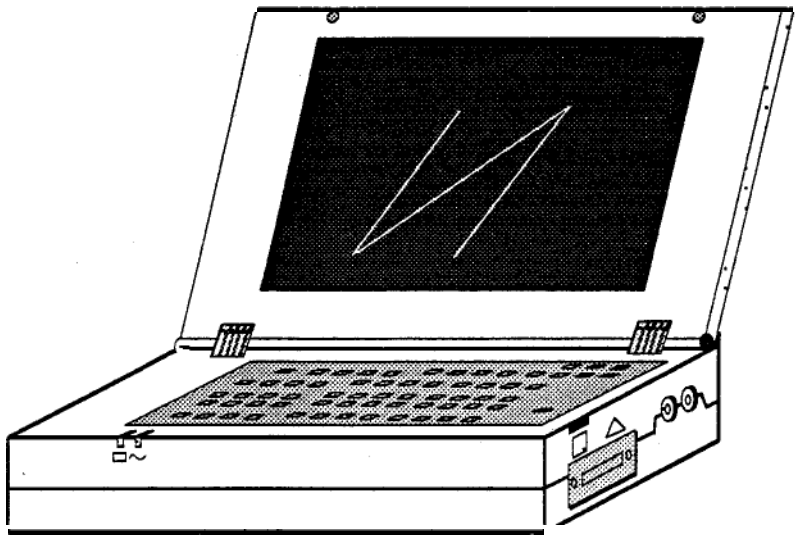
Chapter 1
Operating Elements

Contents



THE SCHILLER CARDIOVIT AT-5

Introduction

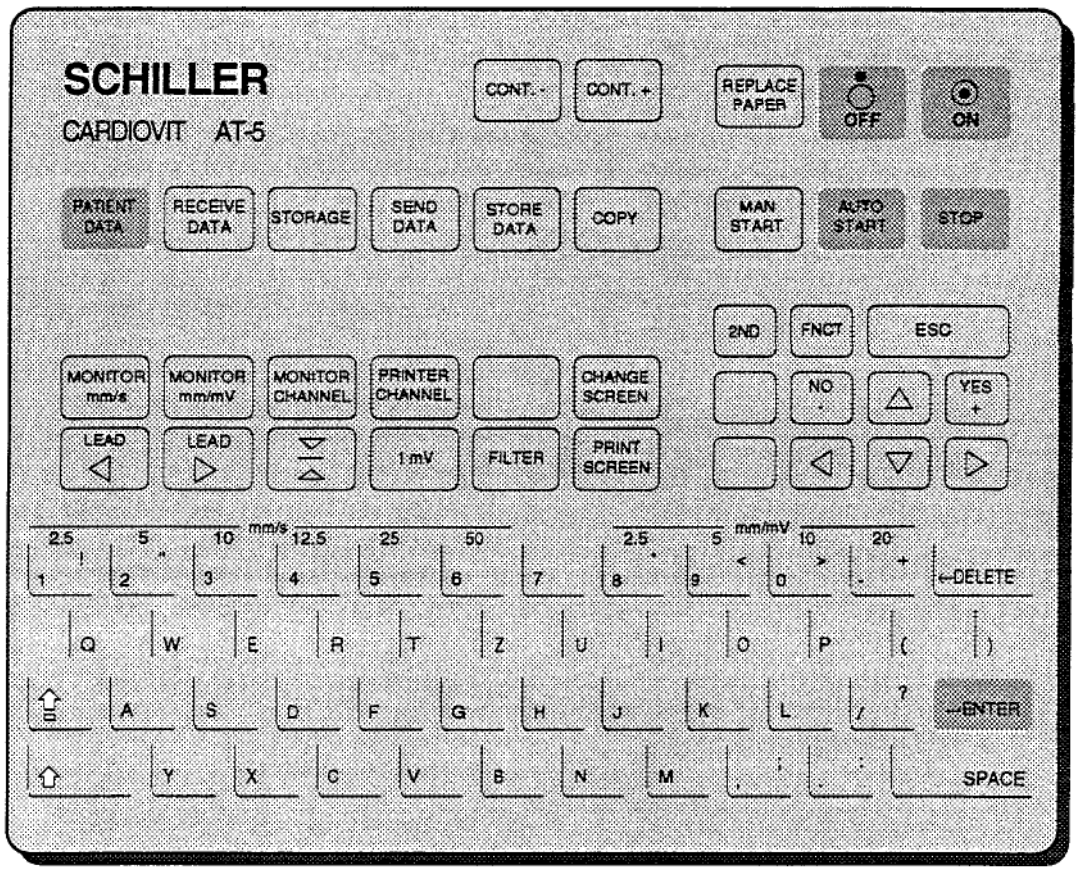
The CARDIOVIT AT-5 is a sophisticated compact, portable ECG Recorder. It carries out resting ECGs with the test results displayed on the integral LCD and recorded on the built-in thermal printer.

An RS-232 interface is provided for data transmission/reception and connection to the SCHILLER PC-based data management program (designated SEMA). The AT-5 also has facilities for connection of external DC inputs.

The main operating and connection modules of the CARDIOVIT AT-5 are as follows:

- Keyboard — The keyboard is divided into three functional areas. The top area comprises the unit ON/OFF keys, the paper replace key and other general function keys. The central area contains dedicated control and function keys, and the bottom area contains the alpha-numeric keys and other general function keys.
- LCD Screen — The LCD screen displays the real-time ECG traces and certain operating and status information. Under operator control the display also gives menu options and displays operator entered data. The display is folded down when not in use.
- Thermal Printer — The printer provides hard copy of test results.
- Right-hand Side Panel — The right-hand side panel contains the ECG patient connector and the experimental dc input connectors.
- Left-hand Side Panel — The left-hand panel contains the paper tray
- Rear Panel — The rear panel contains the RS-232 interface, the mains connector and the ground connector. The program pack is also accessed from the rear panel.

Alpha-Numeric Keypad



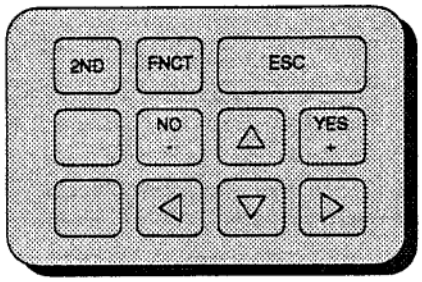
The top line of the alpha-numeric keyboard is dual purpose and when the unit is in the ECG mode, the number keys double as control for the direct setting of speed and sensitivity. Otherwise, the alphanumeric keyboard serves as a normal keyboard for data input.

The functions of the dual purpose keys on the alphanumeric keyboard are as follows:

DUAL PURPOSE KEYS	
KEY	***FUNCTION***
`1´ to `6´	Printout Speed Selection 2.5, 5, 10, 12.5, 25, or 50 mm/s
`8´ to `_´	Printout Sensitivity Selection 2.5, 5, 10, or 20 mm/mV

Control Keys

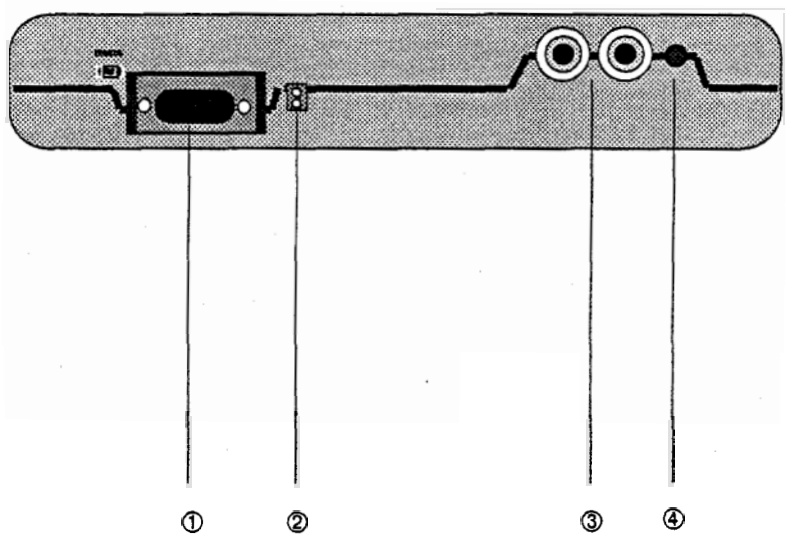
The general purpose keys to the right of the alpha-numeric keypad, are as follows:



FNCT	Call up main menu / return to Monitor mode
ESC	Return to previous menu
YES +	Change setting / disable command
NO -	Change setting / enable command
2ND	Select second function/menu

The direction keys are used to move the cursor in order to make menu selections

Side Panel



The following are located on the side panel:

1. EKG / ECG Socket for patient cable

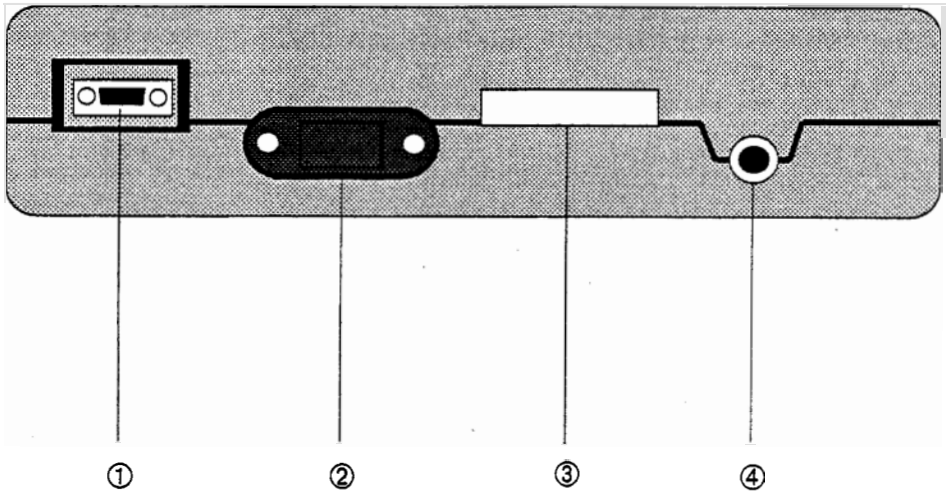
   Note: **The socket is BF rated, that is fully** floating and isolated, defibrillation protected, suitable for intra-cardiac application.

2. ECG Cable Tester
3. DC inputs: DC1, DC2 - 0.5V/cm
4. Reset Key - all stored information is lost when this button is used

WARNING

BE AWARE THAT ALL STORED INFORMATION IS LOST WHEN THE RESET BUTTON IS ACTIVATED !!

Back Panel



The following are located on the back panel:

1. RS-232 port for data transmission / reception
2. Mains Connector
3. Program Pack
4. Potential equalisation (ground) connection

POTENTIAL EQUALISATION

TO PREVENT THE POSSIBLE BUILD UP OF STATIC CHARGES, AND TO REDUCE EXTERNAL AC INTERFERENCE, IT IS RECOMMENDED THAT THE POTENTIAL EQUALISATION STUD IS CONNECTED TO COMMON GROUND.

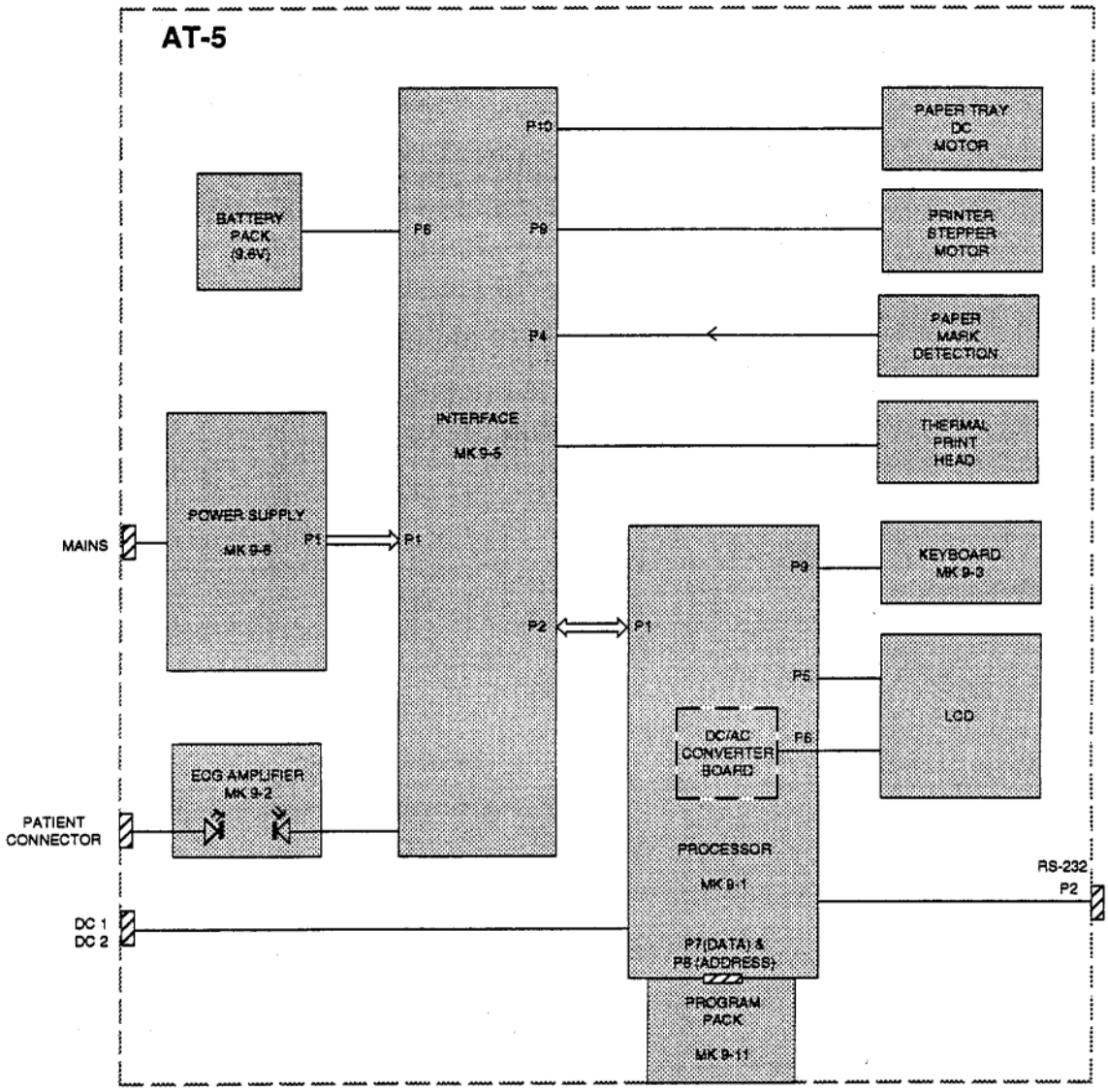
ATTACH THE YELLOW/GREEN GROUND LEAD (2.310005 - SUPPLIED WITH THE UNIT), BETWEEN THE POTENTIAL EQUALISATION STUD, SITUATED ON THE REAR PANEL, AND THE HOSPITAL/BUILDING COMMON GROUND.

WHEN WORKING FROM AN EMERGENCY VEHICLE, THE VEHICLE COMMON GROUND MUST BE USED.

Chapter 2
Functional Description

Contents

Block Diagram



AT-5 Basic Block and Interconnection Diagram

Brief Description

The AT-5 comprises the following boards and major functional areas:

Power Supply

The power supply board generates all voltages for the AT-5 (except the isolated supplies on the ECG Amplifier) from either the mains input or the battery pack. The Nickel Metal Hydrid battery pack allows the AT-5 to operate for about one hour when mains is not present.

Processor

The Processor Board is the master control for all peripherals and contains the master CPU, system timing circuits and the unit RAM memory. This board also contains the following:

- Program Pack containing the unit software
- Print control and keyboard timing circuits
- LCD data and control circuits
- RS-232 controller
- DC connectors (DC1, DC2)

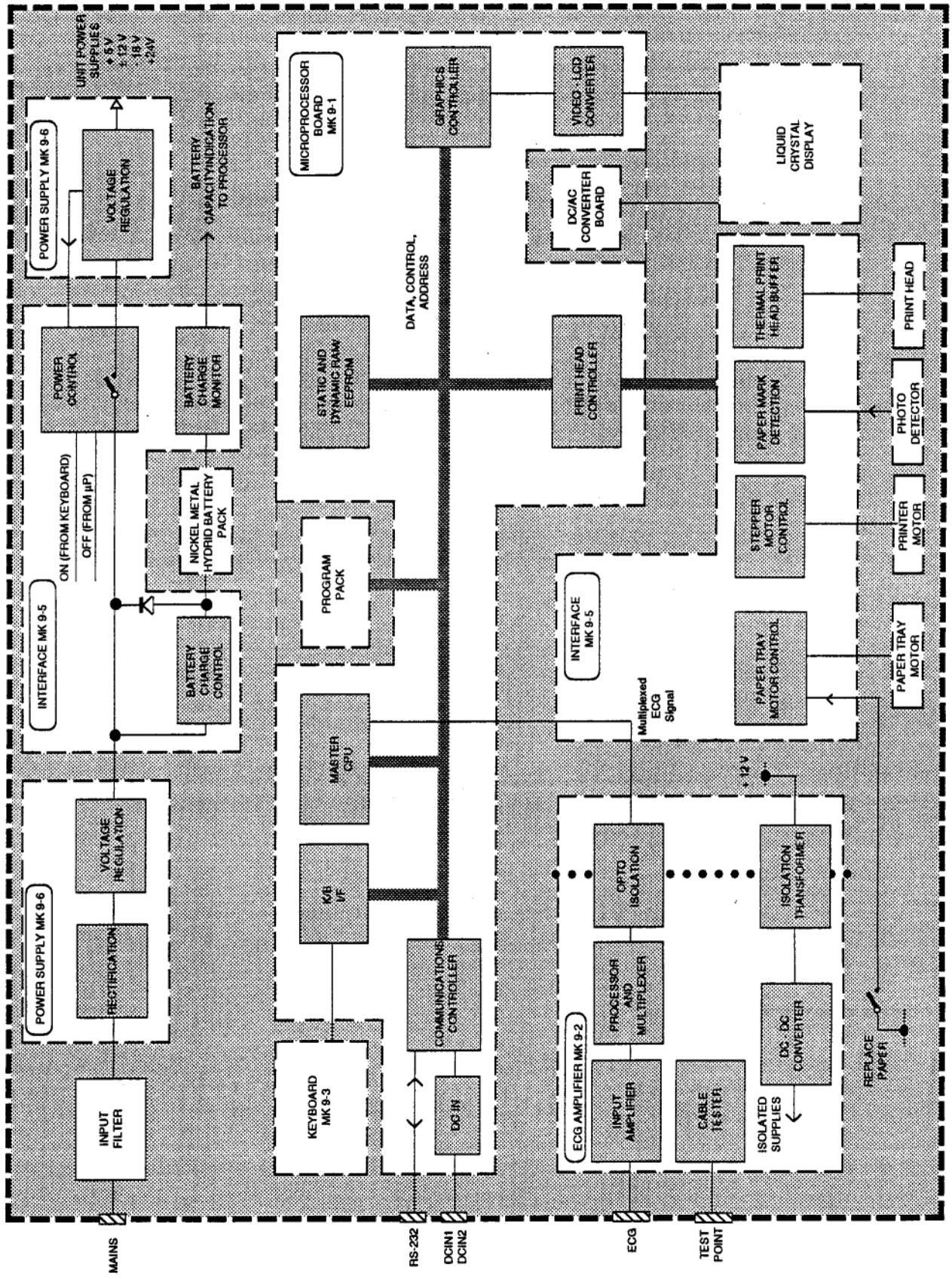
ECG Amplifier

This board amplifies the incoming patient data and serialises the data for transmission to the master processor. To ensure absolute safety of the patient, both the power supplies and the data communication link with the master processor, are isolated.

Interface

The Interface board contains the following:

- Paper mark detection circuit
- Thermal print head data buffers
- Stepper motor control circuit
- Control circuit for the paper tray dc motor
- Battery charger circuit
- Battery capacity monitor circuit
- Unit ON/OFF switch



AT-5 Functional Block Diagram

Functional Description

Power Supply

The applied voltage is rectified. The rectified voltage is then applied to a mains switching regulator which produces a resultant dc voltage of approximately +15V. This voltage is applied to the battery charge controller and the voltage regulator circuits via an electronic ON/OFF switch.

The power on/off switch is set by the following:

ON On signal from the keyboard (to latch the switch on)

OFF Off signal from the Microprocessor (Off key pressed on keyboard, Reset pressed, Batt Down (5V supply below 4.75V))

Overcurrent condition on the +5V rail or the +24V rail

Undervoltage on the +15V input

The Nickel Metal Hydrid battery pack comprises eight, 1.2V cells giving a nominal voltage of 9.6V. A current sense battery charge regulator circuit controls the charging of the battery. Battery charging current is monitored so that the master CPU can calculate the present capacity of the battery for display on the LCD, and to flash the battery LED when capacity is low.

Processor and Memory

The AT-5 is controlled by a high speed, CMOS 68000 processor with a 16-bit data bus and 23-bit address bus. The clock speed is 16.7 MHz. The processor works in conjunction with a dedicated gate array.

The working RAM memory comprises 256 kByte of static RAM and 2MByte of dynamic RAM. The dynamic RAM holds the ECG data and other variables and an EEPROM holds the operator selectable parameters. The unit software comprises 256kBytes of EPROM contained on the program pack.

ECG Signal

The ECG signal from the patient is low-pass and high-pass filtered, amplified and applied to the processor and multiplexer circuit by the ECG Amplifier board. The signals are converted from analog to digital and transmitted to the CPU over opto-isolators.

Keyboard

The keyboard is a matrix style circuit which is periodically scanned by the processor via the Keyboard Interface circuit.

Functional Description

Printer Control

The Thermal Print Head is controlled by the print head controller and timer circuit. The print head controller serialises the parallel data written by the CPU into a 16-bit FIFO register. The timer circuit controls how long current is applied to the head, and thus the intensity of the printout.

The printer stepper motor speed is controlled by a timer circuit.

Graphics Control

The display data is generated in the graphics processor circuit. The graphics processor outputs a VGA standard serial video signal. The video signal is converted to an LCD signal by the Video - LCD converter.

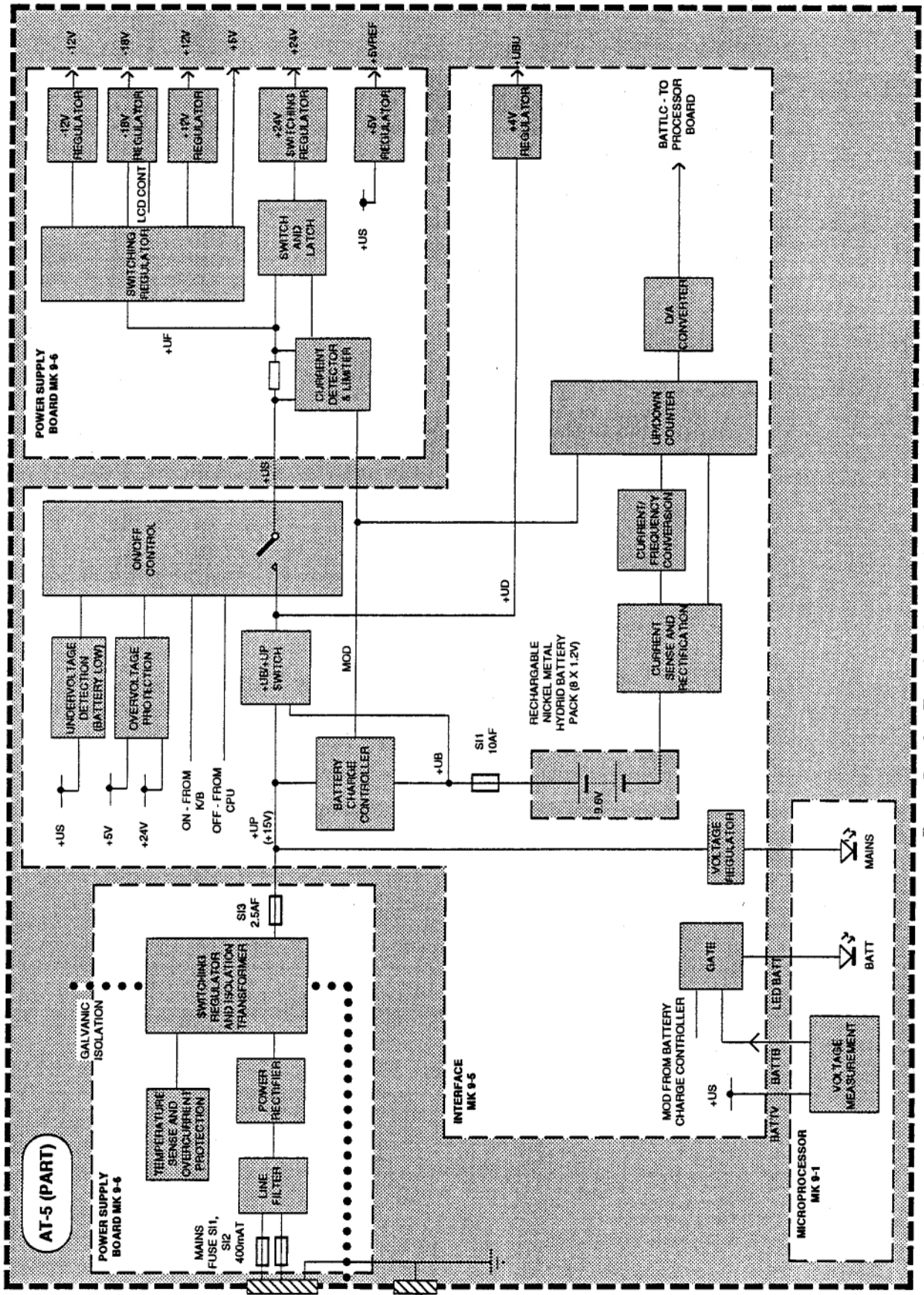
External Input/Output

DC Inputs

The dc input connectors allows analog signals, for example from an ultrasound device or a phono/ pulse recording unit, to be input to the AT-5. The analog inputs are converted to a digital level and presented on the data bus. The maximum input voltage is 2.5V p-p.

RS-232

The communications controller contains a USART and interface circuit which performs the parallel/serial and serial/parallel conversion for the transmission and reception of data and provide signal level compatibility with RS-232 standard.



Power Supply - Functional Block Diagram

Power Supply

AC to DC Converter

Mains is applied to the line filter via two 400 mA, slow-blow fuses. The line filter incorporates a temperature variable resistor to ensure that the current is limited at initial switch-on. After a few seconds the resistor warms, the resistance drops and normal power is supplied.

The mains input is full-wave rectified by a bridge rectifier to produce a dc voltage approximately 1.4 times higher than the input voltage. An input filter, formed by L2 and C40, C41, prevents high frequency interference getting back on the mains.

The switching regulator comprises power MOS FETs (Q5 and Q6) which switch the voltage in isolation transformer Trafo2 so that the secondary winding, after rectification and regulation, produces +15V (+UP) with a maximum current of approximately 1.6A. The pulse width and frequency is set by a controlled oscillator (U10 and C30) with a nominal frequency of 35kHz which control the FET drivers (U7A and U11A). The oscillator frequency is set by feedback amplifier circuit U8B and associated components monitoring the positive value of the primary at C14 (400Vdc) and regulating the oscillator so that a switched value of 0V to 400V is present at TP32 (with a pulse width proportional to the input voltage). A power limiter circuit formed by U8A and associated components, monitors the 0V and limits the current to approximately 1.6A.

Two protection circuits are incorporated into the mains circuit - an undervoltage (overcurrent) protection circuit and a high temperature cutout. The +15V supply is monitored via U10D and U10E. If the voltage goes below approximately 8V, indicating high current and a possible short circuit, the output from the feedback amplifier (U8B) is shorted and the power supply is switched off. Similarly the internal temperature of the unit is monitored by NTC resistor R153 and when the temperature reaches approximately 60° the power supply is turned off.

On/Off Control

Main Power / Battery Power Switch

When mains is connected +UP is present and, via U21, is routed to the on/off switch U22, and the battery supply +UB is cut off. When +UP is not present (mains not connected) +UB is routed (via U21) to the on/off switch.

On / Off, Battery Low Voltage Detection and +5V and +24V Overvoltage Protection

The on/off switch (U22) is initially switched on by the ON signal from the keyboard, and then latched by the +5V reference supply via comparator U201A and NOR gates U19A..D. When the OFF signal from the processor goes low, the output of U201A goes low and the power supply is switched off.

The battery voltage is monitored by comparator U201A (monitoring the +US power rail connected to the - input of the comparator via voltage divider R83, R82). If the voltage drops below 8.5V (battery voltage low) the output of U201A goes low and the power supply is switched off.

In the same manner the +5V and +24V rails connected to the - input (via dropper resistors), are monitored for overvoltage. If the negative input goes higher than the positive input reference (indicating +5V or +24V overvoltage) the output of the comparator is low and the unit switched off.

Power Supply

Over Current Protection

The current is measured with current sense resistor R125. Comparator U26A controls overcurrent switch U25 to cut the +24V printer supply when current exceeds approximately 800 mA. This equates to the +24V supply dropping below approximately 15V in mains operation or 10V in battery operation. A latch circuit formed by Q14 and associated components, keeps U25 switched off. The MOD signal from the battery charge controller, sets a lower threshold when the battery is charging and the TIMEOUT signal from the Interface board disables the latch on initial switch on.

Power Regulators

+24V Switching Regulator

The oscillator formed by U71D and, C103 and associated components is set by a feedback controller circuit (U2A). Power drivers U23A and U23B, switch FET on Q16 and U24 to switch energy choke L11.

A 24V output filter is formed by L10, C101 and C105.

+5V Switching Regulator

Power FETs U21 and U22 form a push-pull circuit which switches the supply to loading coil T2. The power FET control circuit is formed by U2B which monitors the ac feedback (via decoupler C64) and dc feedback (via R97) to control the switching oscillator (U17A, C68). A gate booster for the power FETs is provided by U16.

Secondary windings of T2 provide voltages of 13V and 25V. These are used by linear voltage regulators to produce the regulated +12V, -12V and -18V supplies.

The -18V supply is used by the LCD to generate the backlight voltage. The LCD KONT. signal (controlled by the CONT+ and CONT- keys on the keyboard) alters the -18V voltage and thus the LCD contrast.

The power supply distribution is given on the following table.

POWER SUPPLY DISTRIBUTION

Boards	Power Supplies					
	+ 5 V (VCC)	+ 12 V	- 12 V	-18V	+UBU Backup	+ 24V
Processor Board	✓	✓	✓	(LCD dc/ac converter board)	✓	
ECG Amplifier	✓	✓				
Interface Board	✓			✓		(Thermal Printer)

Power Supply

Battery Charge Controller

Battery charging is controlled by a dedicated battery charge controller chip U9. The controller switches FET U10 to charge the battery via smoothing filter and charge capacitors L2 and C26..31. When the battery is being charged the MOD signals are active and used to light the Battery LED and to lower the current threshold of the current limiter circuit (see previous paragraph). Additionally the MOD signal is used by the battery capacity circuit to reset the counter when the battery is fully charged.

Battery LED

When the battery the being charged the Battery LED is lit by the MOD signal. When the unit is operating with battery power the voltage of the +US supply (via voltage divider) is measured by the processor which sets the LEDB signal. When the battery capacity is approximately 25% the LED flashes. The unit is switched off when the voltage is approximately 8.9V.

Battery Capacity

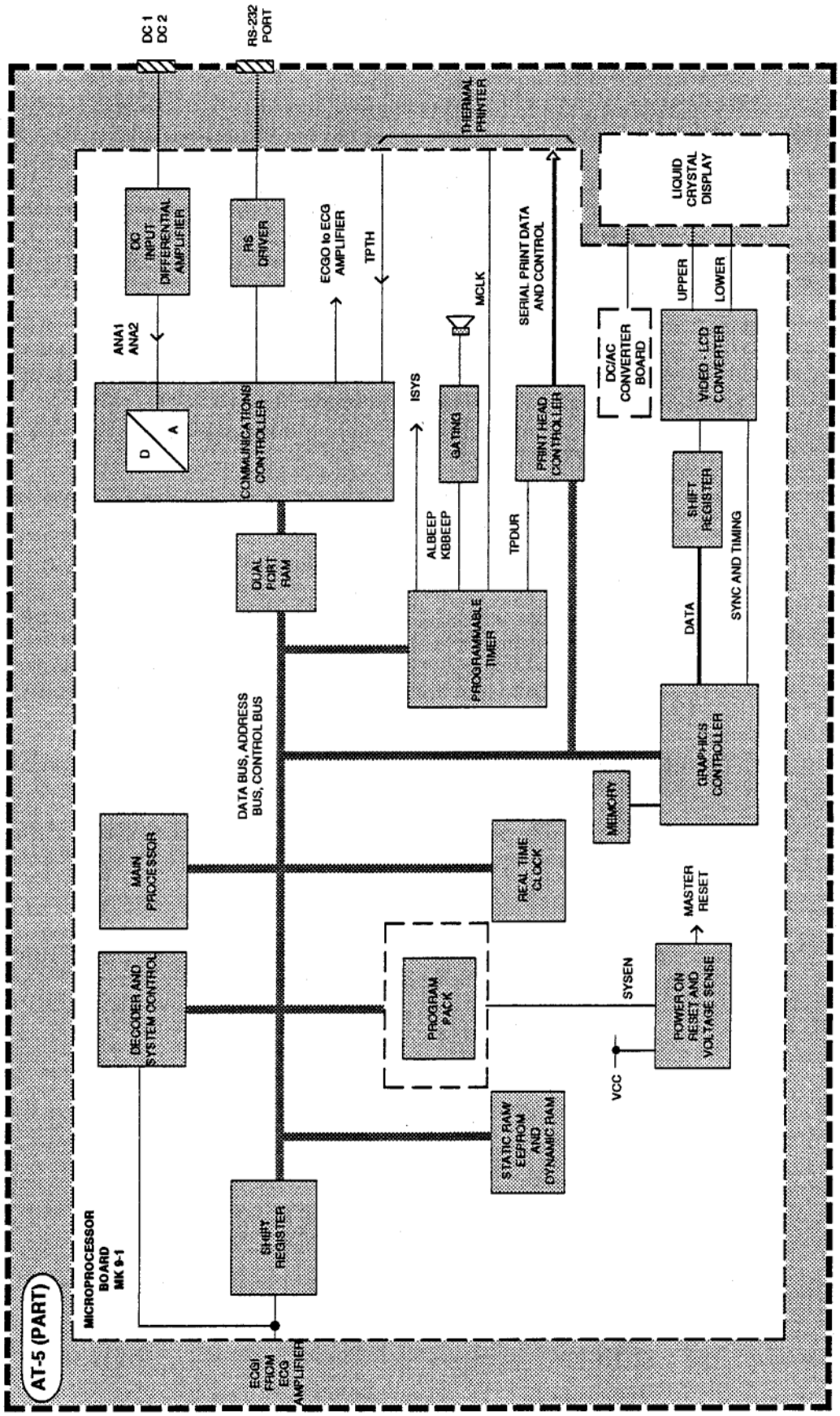
The battery controller circuit measures the charge/discharge current of the battery to enable the CPU to calculate the capacity of the battery.

Operational amplifiers U5B and U5A form a current rectification and measurement circuit the output of which is fed to a current frequency converter circuit. The current/frequency converter provides a frequency output that is directly proportional to the battery charge or discharge current. The output of the current/frequency converter clocks an up/down counter which is used to indicate the charge/discharge current and charge/discharge time of the battery, and thus the actual capacity of the battery. The direction of the counter (down or up - charging or discharging) is set by the UP/DOWN signal set by +5VN generated when mains is connected.

The frequency of the current/frequency converter at a charge or discharge rate of 1A is approximately 31.3Hz.

The counter counts up when the battery is discharging and down when the battery is charging. The count is converted to an analog value by D/A converter U13 for use by the CPU in determining the charge state of the battery. When the battery is fully charged (counter all `1´s), the DAC output is 0V.

The counter is preset when the battery is fully charged. This is carried out by the PRESET signal generated from the MOD signal in the battery charge controller.



Processor - Functional Block Diagram

Processor Board

Master CPU

The master CPU (U16) works in conjunction with a dedicated gate array IC (U47), the main functions of which are as follows:

- To decode the address bus (A17 to A23) and generate the chip select (CS) signals for the memory and the peripherals.
- To generate interrupt priority signals (IPL0, IPL1, IPL2) for the main processor - the highest priority interrupt is `7' the lowest `1'.
- To generate the row address strobe (RAS), column address strobe (CAS) and address multiplex control signals for the dynamic RAM.
- To synchronize the clock of the (asynchronous) ECG input signal.

Memory

Program Pack

The Program Pack comprises two 128kByte flash EPROM chips containing the AT-5 software.

Dynamic RAM

The Dynamic RAM comprises four, 1M x 4 RAM chips (U12..U15) arranged in two bytes (lower - D0 to D7, upper D8 to D15). They are transparently refreshed via CAS before RAS control protocol at approximately 1kHz. The dynamic RAM stores the following data:

- Printer pixel pattern
- Printer text data
- Rhythm ECG data

Static RAM and EEPROM

The two 128k RAM chips (U39 & U40) use the back-up power supply (UBU) so that the stored data is not lost when the unit is switched off.

The static RAM stores the following:

- Last 10 seconds of ECG data
- Patient data

A 64k EEPROM chip (U35) stores some user defined parameter settings . It shares an enable signal (CSRTCC) with the real time clock (U38).

Processor Board

Communications Controller

The Communications Controller comprises a single chip processor (U45) with built in RAM and ROM. It carries out the following functions:

- Controls the serial RS input/output
- Serialises the ECG Amplifier board control signal ECGO
- Incorporates an analog to digital converter for:
  - ANA1 and ANA2 from the DC inputs
  - TPTH temperature signal from the thermal print head
  - Battery voltage
  - Battery capacity

Communication over the RS port is via an RS driver chip (U47) to convert to the standard RS-232 12V signal level.

Thermal Print Head Controller

The thermal print head controller circuit comprises programmable generic array logic (GAL) chips and latch buffers to serialise the printer data and generate the required clock and strobe timing signals.

Data to be printed is presented on the data bus and strobed through first in, first out (FIFO) memories (U2 and U3) in two bytes. The GAL chips (U4..U7) serialise the data and generate the timing and strobe signals. The mark/space ratio of the timing signals are adjusted by the TPDUR signal to compensate for the varying ambient temperature and resistance of the print head. To provide a better quality print-out the print head data is `cycled´ so that each pulse is repeated eight times. This is carried out by FIFO memory U1.

The TP clock frequency is 4 MHz and the TGATE signal is 2kHz (is this correct?). The strobe signals are 2kHz. See Appendix Timing diagrams.

Graphics Controller

A VGA standard signal (480 rows with 640 pixels/row with a horizontal sync of approximately 31.8 kHz and a vertical sync of 60 Hz), is generated by a graphics processor chip (U29) which works in conjunction with two RAM chips (U32 and U33) for the pixel memory. The video controller also generates all the necessary protocol signals (HSYNC, VSYNC etc).

The parallel display data is fed to two 8-bit shift registers (U26 and U27) which together convert the 16-bit parallel output from the video controller to a serial video format (QH output from U27). The video signal to the Video/LCD Converter is gated with signal SCINV which inverts the screen image (changes the LCD to white on black image), when set.

Certain control and enable signals from the video controller are further decoded by GAL U31.

Processor Board

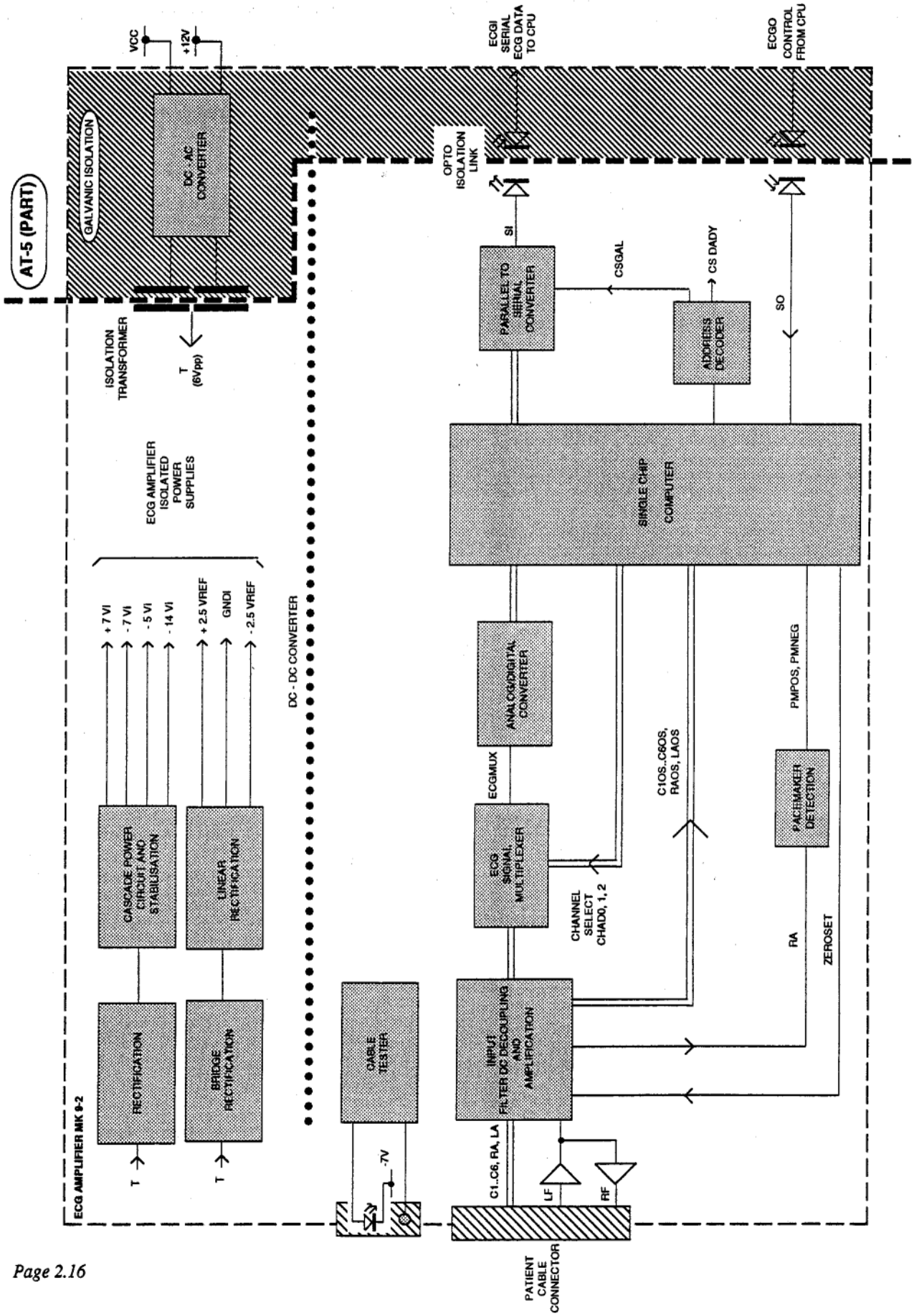
Video - LCD Converter

The video/LCD converter chip (U54) converts the serial video signal into the correct LCD format and generates all the timing and strobe signals required. Four upper and four lower control and data signals are output to the LCD along with two clock signals. A working 128k memory for the converter chip is provided (U55).

Power On Reset

The Power on reset circuit is formed by U54 and associated components. The circuit controls the master reset of the CPU. This circuit has three functions as follows:

- Provides a delay on initial switch on to ensure that the power supply is fully stabilized and to give the 200ms reset time required by the 68000 processor
- Ensures that the system is inoperative and in reset mode when the SYSEN indicates that the Program Pack is not present
- Disables the unit if the +5V rail drops below +4.75V



ECG Amplifier - Functional Block Diagram

ECG Amplifier

ECG Isolated Power Supplies

The DC/DC converter circuit produces all the isolated power voltages required by the ECG Amplifier circuit.

The VCC rail from Power Supply MK 9-6 is applied to isolation transformer T2. The pulsing circuit comprises a 30 kHz oscillator U3 and associated components to switch MOS FETs Q1 and Q2 via flip-flop (U4A) and drivers (U5A and U5B). The secondary winding of the isolation transformer produces 6Vpp (T).

A Schottky diode and capacitor network rectifies the ac power line T which is then applied to a linear regulator circuit. Operational amplifiers U6A and U6B and transistors act as a variable resistor to stabilise and produce the ±2.5V reference for the ADC.

The ac power line T is also used by an unregulated cascade circuit to produce the ±7Vi and-14Vi supplies.

Servicing Note: When taking measurements always ensure that the isolated ground is used for reference.

ECG Signal

The incoming ECG signals RA, LA, and C1 to C6 are 41kHz low-pass filtered and applied to non-inverting operational-amplifiers giving a gain of 11. The signals are then dc decoupled (C61 et seq), and further low-pass filtered and amplified to give an overall amplification of approximately 250 and an overall low-pass frequency of 400Hz. A baseline reset signal from the processor (ZEROSET) resets the ECG signals when baseline drift occurs (and the baseline reset key on the keyboard is pressed).

The incoming amplified and filtered signals are applied to the multiplexer. The multiplexed output is directly converted to a digital value by U21 and applied to the ECG processor U27. The processor sets the gain, carries out some signal processing, and provides interface control. Lead off detection and offset calculation is performed from the offset (OS) signals.

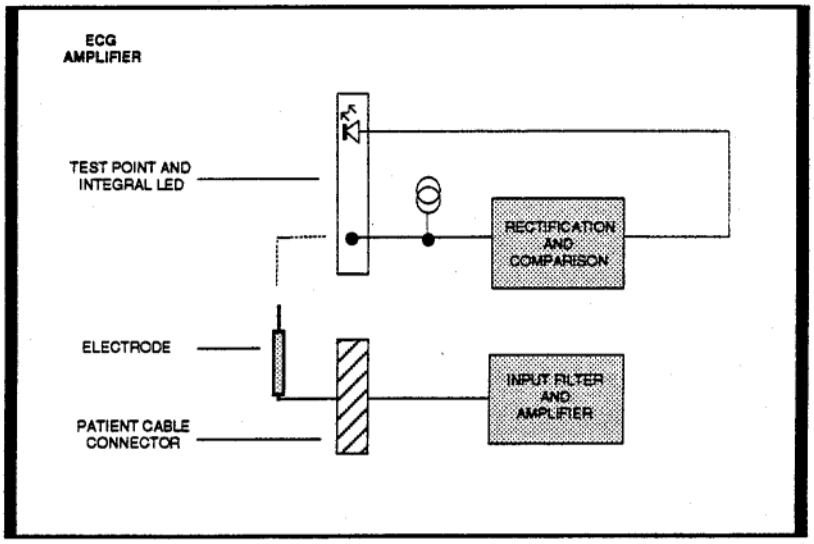
The ECG signal parallel output from the processor is converted by shift register U22 to serial and output to the master CPU via a multiplexer and GAL circuit (U23) and an opto-isolator.

Pacemaker Trigger

The pacemaker detection circuit differentiates the ECG signal from the right arm (RAOS), rectifies it and generates the PMNEG and PMPOS signals. The PMPOS signal indicates the positive going edge of the pacemaker pulse, PMNEG the negative going edge.

ECG Amplifier

Cable Tester

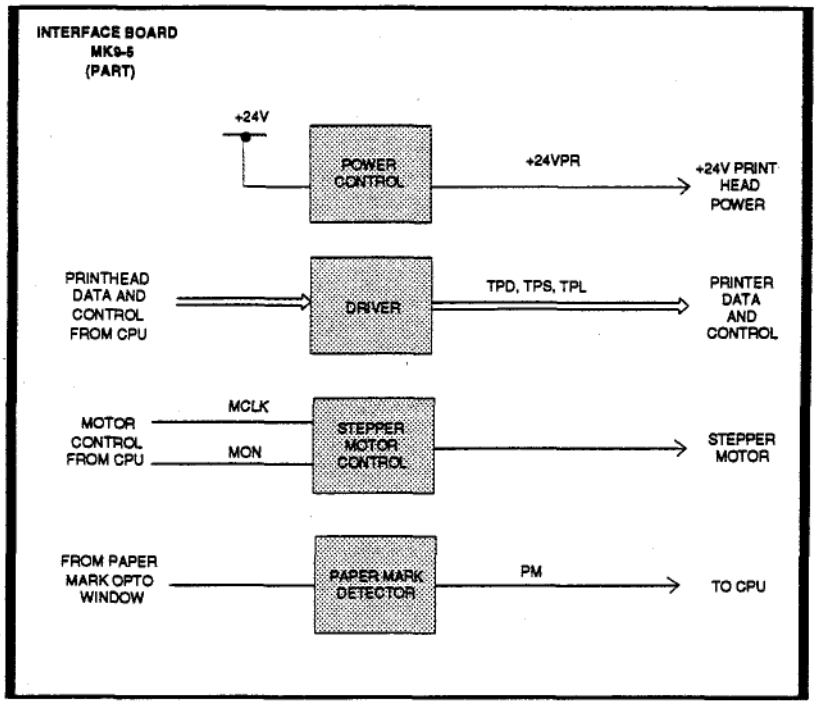


The cable tester circuit checks the resistance of an individual lead in the patient cable. The resistance of the lead must be between 10kOhms and 1MOhms.

The cable tester comprises a 3.3kHz oscillator and comparator circuit. The oscillator is connected to the test point and when a lead is connected to the test point, the potential on the lead (from the input filter and amplifier circuit) alters the waveform. The waveform is rectified and, via a comparator (U7B) lights the LED. The comparison voltage at U7B is 1.45V and the generated waveform is at a base level of approximately -17V with an oscillation of 5V.

Printer Interface and Paper Tray Control

Thermal Printer Control

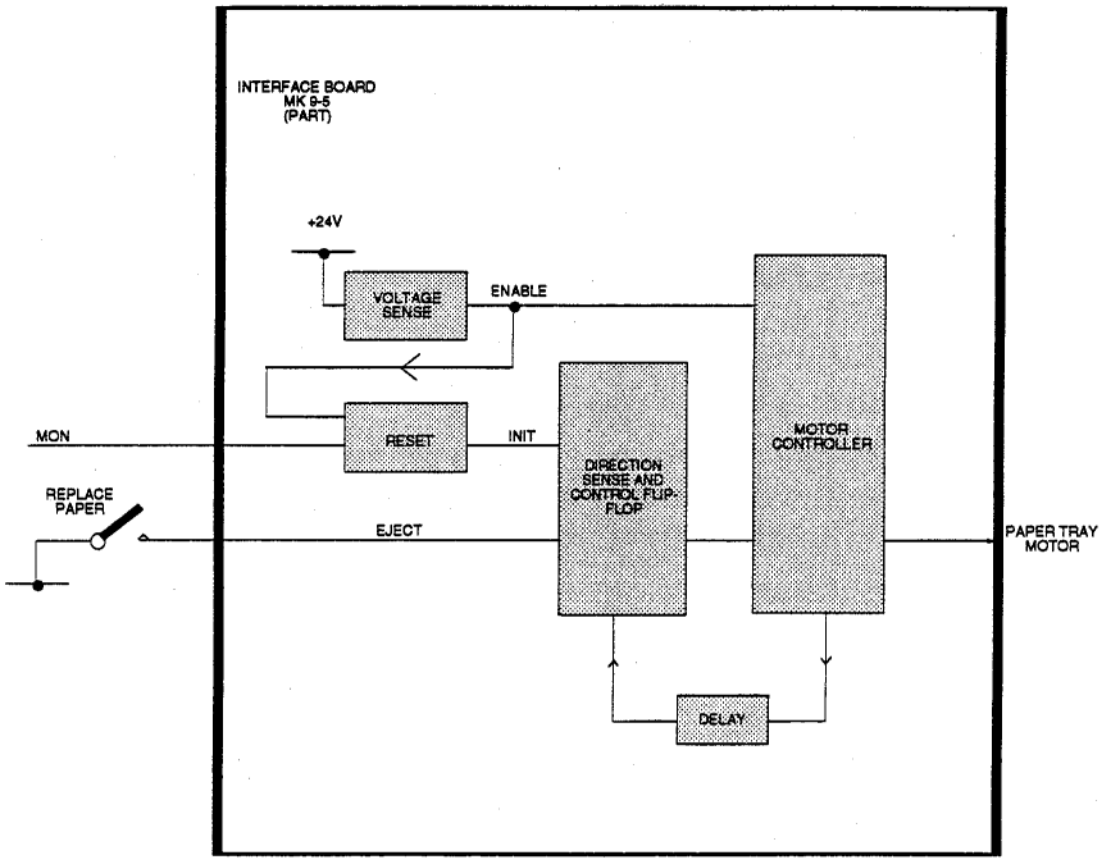


The Thermal Printer stepper motor is controlled by stepper motor controller U16. The MON signal from the processor is the enable signal for the controller and the MCLK signal sets the speed; 140Hz gives a paper speed of 2.5 mm/s, 280Hz gives a paper speed of 5 mm/s .. and 2800Hz gives a speed of 50mm/s.. The driver circuit incorporates a current sense circuit. The current of the motor is approximately 100mA, depending on the step rate set.

The printer data, the strobe and the clock signals are buffered by U15. The strobe frequencies (TPS0 and TPS1) are 2kHz, the clock (TPCLCK) is 4MHz, and the latch frequency (TPL) is 2kHz.

The paper mark detector is an opto sense circuit. The output from the detector is fed to an operational amplifier (U1) to set the PM signal when a paper mark is detected. The input from the optocoupler is 0.4V to 0.6V for white paper and 3.5V to 4V for black paper (paper mark). The PM output signal is logic 0 when a paper mark is detected.

Printer Interface and Paper Tray Control



Printer Interface and Paper Tray Control

Paper Carriage Control

Initial Switch-On

On initial unit switch-on the ENABLE signal is set. This sets the INIT pulse which resets Motor Controller flip-flops U24A and B and retracts the paper tray if it is extended. In the same way if a print-out is initiated when the paper tray is extended, the MON signal initiates a reset and the paper tray is withdrawn before printing.

Extend Paper Tray

Pressing the REPLACE PAPER key sets the EJECT signal to the flip-flops, via Q12. The flip-flops enable the motor control chip U25 and set the direction of the 24V dual polarity motor (GO IN, GO OUT signals). The motor controller incorporates an `H´ bridge current sense circuit to detect when the paper tray is fully extended. When the paper tray is fully extended the current increases, the motor controller detects this and sets the sense line which, via comparator U26B is fed back via a delay circuit, resets the flip-flops and stops the motor. A delay circuit (C75) prevents the motor being stopped prematurely during the power surge when the motor is initially activated.

Retract Paper Tray

When the paper tray is extended, pressing the REPLACE PAPER key switches off transistor Q12 and activates the EJECT signal. This produces a 'clock pulse' to the flip-flops and activates the GO IN signal to the motor controller. In the same manner as when the paper tray is being extended, the current sense circuit stops the motor when the paper tray has fully returned.

The flip-flop control circuit monitors the printer stepper motor via the MON signal, and the paper tray motor via the Stop signal (paper tray motor active). This ensures that the circuit is disabled if the REPLACE PAPER key is pressed when either the printer motor, or paper tray motors are active.

Voltage Monitor

If the +24V supply drops below approximately 14V the Motor controller is disabled.

Chapter 3
Fault Diagnosis

Contents

Introduction

The purpose of this chapter is to provide fault-finding procedures that will quickly and efficiently identify a fault to a specific module. The fault-finding procedures are designed so that test equipment is kept to a minimum.

An initial fault diagnosis chart is provided detailing all the general fault indications. When this is followed it will indicate the module where the fault lies or specify a further fault-finding procedure. When more than one module is stated, the first module given is the one most likely to contain the fault. Other modules given should be checked in the order given.

If the initial fault-finding chart does not indicate the area where the fault exists, re-check all the settings and parameters that have been entered (for the particular task that fails). If these are correct, check the software. If this is correct suspect external connections.

If a key operation or menu selection is required when carrying out the functional check, the key sequence required is given in parenthesis '<>'. The character(s) given in parenthesis is the actual character(s) printed on the key. When a key sequence is provided it must be followed in the order given. For example the key sequence to give the Macro screen is:

<FNCT> <9> <ENTER>

This requires that the Function key on the keypad is pressed, followed by the `9´ key followed by the Return (or Enter) key.

Test Equipment

The following proprietary and dedicated test equipment is the minimum that is required to fault find and carry out any board checks and adjustments on the AT-5.

The list of proprietary equipment is not comprehensive. Recommendations of suitable proprietary test equipment can be obtained from the SCHILLER Service Department.

Proprietary Test Equipment/Tools

- ECG Emulator, eg Phantom 320*
- Oscilloscope
- Digital Multimeter*
- Stabilised Power Supply
- Standard tool kit with a selection of cross-bladed, flat-bladed and posi-drive screwdrivers, Pliers and general tools*
- Soldering Iron
- RS Test Plug Part Number to be defined
- 5mm hexagonal allen key used for the removal and replacement of the print head.

In addition to the above a SCHILLER patient cable (SCHILLER Number 2.400011) is required when carrying out simulated ECG tests.

* Indicates Essential Equipment for basic AT-5 fault finding

Fault Diagnosis

Use the fault finding charts and procedures on the following pages to indicate a faulty area or module. In most cases the fault finding charts should indicate the most likely faulty area.

When a possible faulty module is indicated by the fault finding charts, the module must be replaced. When a module has been replaced specific test parameters and setting-up of the module may be applicable. The removal and replacement instructions for all replaceable modules, along with any set-up or check procedures required, are given in Chapter 5.

Safety Notices

WARNINGS

BEFORE COMMENCING ANY REMOVAL OR REPLACEMENT PROCEDURES ENSURE THAT THE MAINS POWER SUPPLY IS SWITCHED OFF AND THAT THE MAINS CABLE IS REMOVED.

CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED AND WITH MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

THE AT-5 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS:

◊ WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT.

◊ PERSONNEL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS

◊ ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

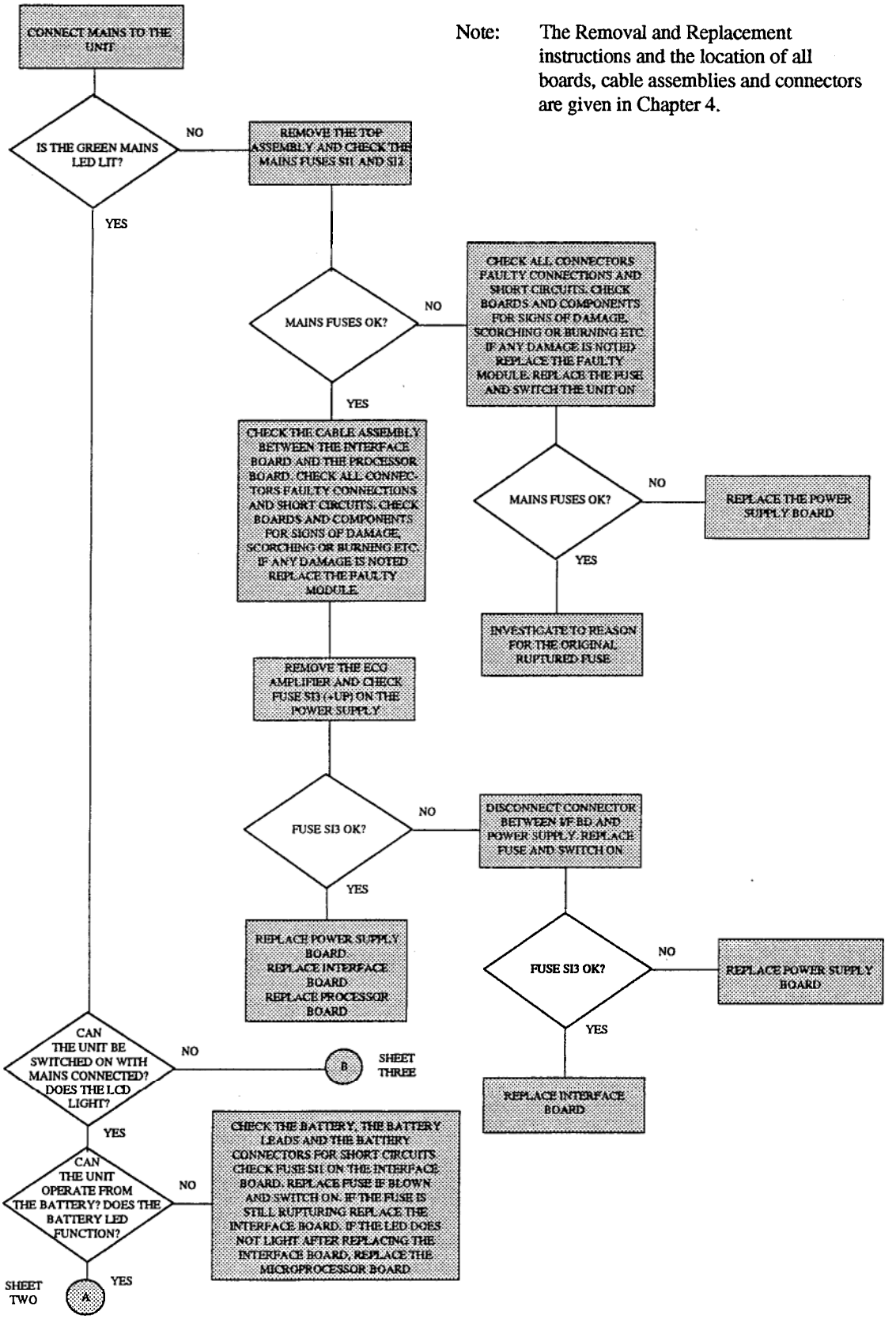
THE TOP ASSEMBLY IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING WHEN CARRYING OUT MAINTENANCE PROCEDURES, ALWAYS PLACE THE UNIT ON A SOFT NON-ABRASIVE CLOTH.

TAKE CARE NOT TO PLACE ANY STRAIN ON THE CONNECTING RIBBON CABLE WHEN REMOVING THE TOP ASSEMBLY. ENSURE THAT THE CABLE ASSEMBLY IS NOT CRIMPED OR TWISTED AND THAT THE TOP ASSEMBLY IS NOT PLACED ON THE CABLE ASSEMBLY.

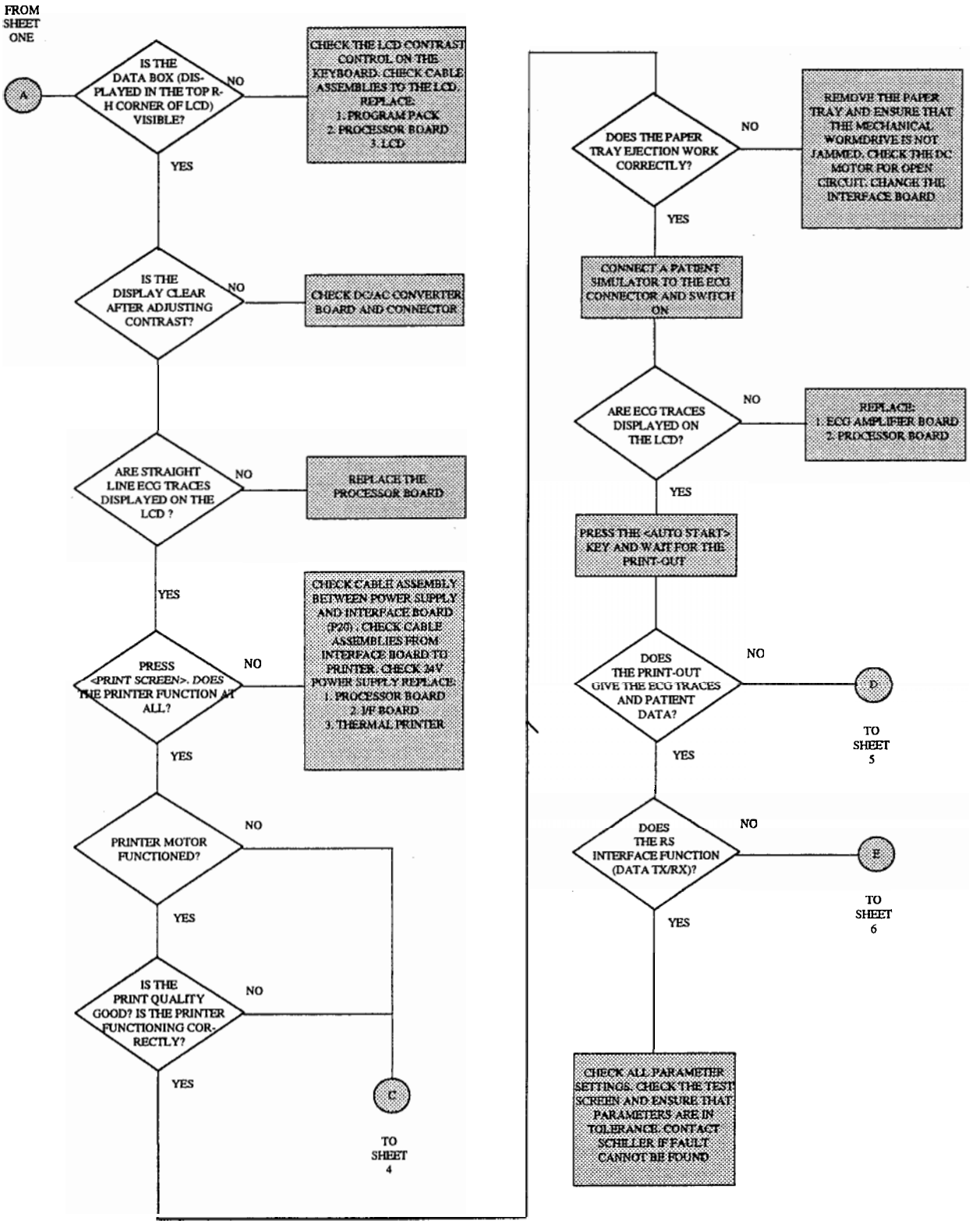
CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

THE PROCEDURAL STEPS GIVEN FOR EACH MODULE MUST BE FOLLOWED IN THE ORDER GIVEN.

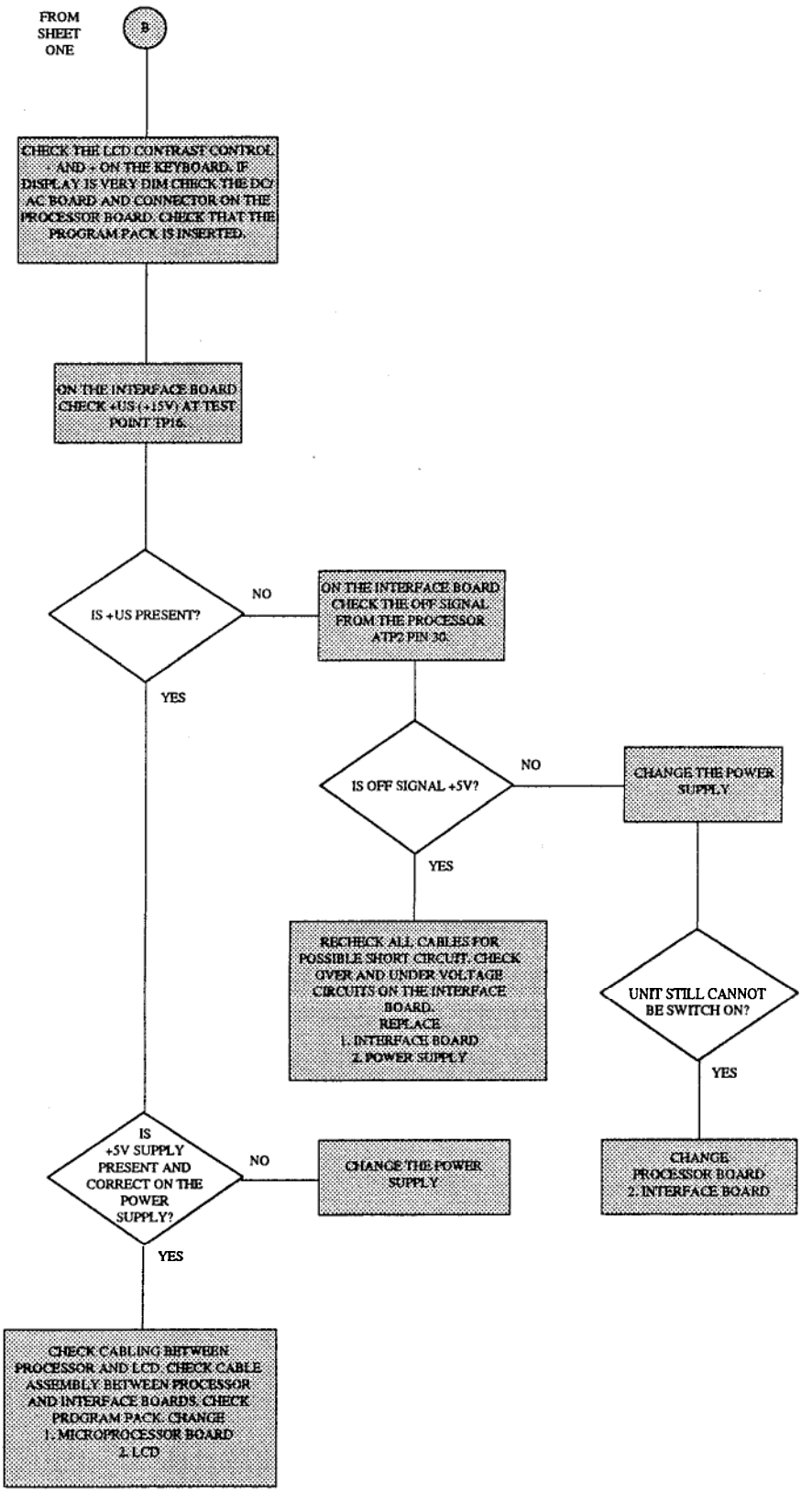
Note: The Removal and Replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.



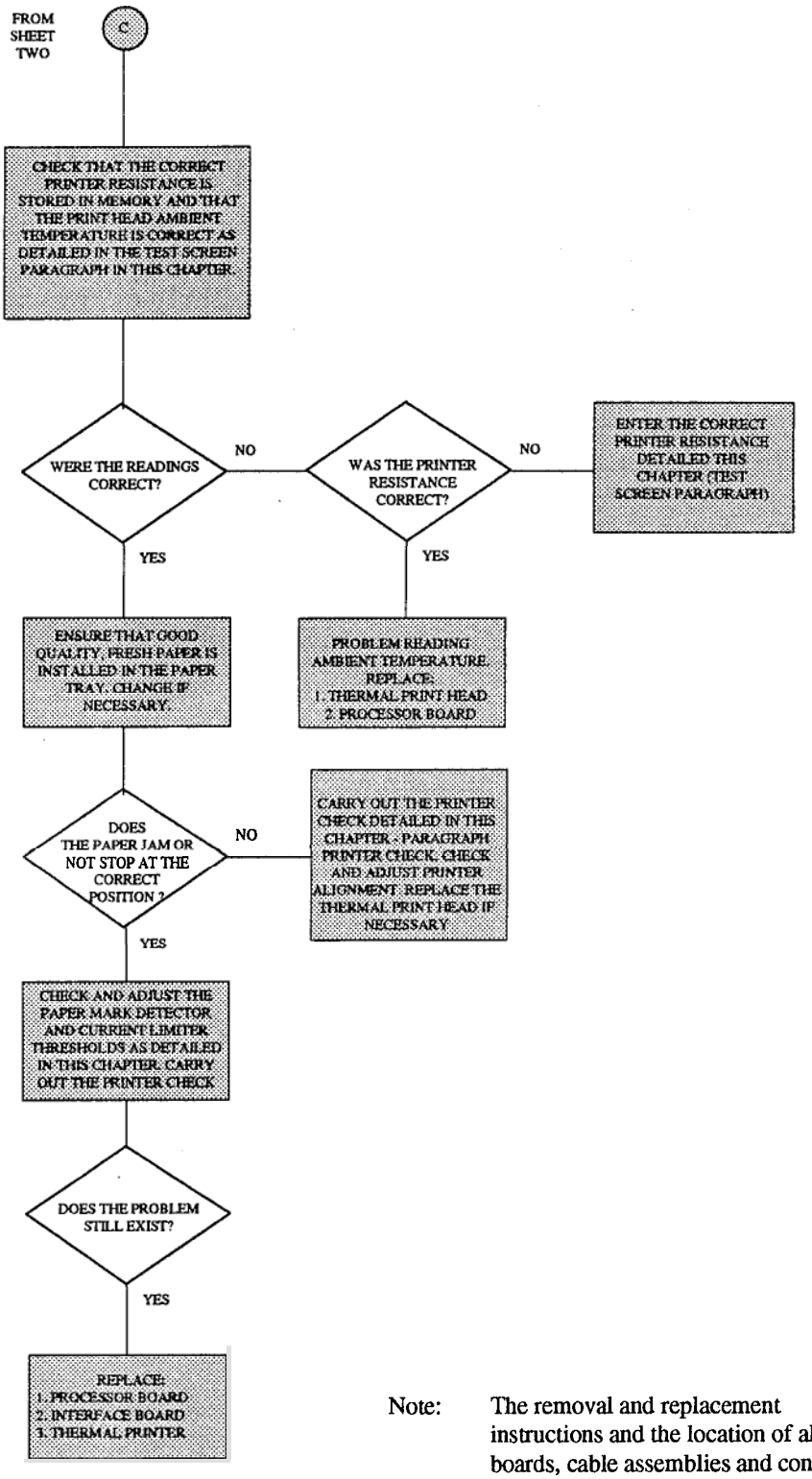
AT-5 Fault Diagnosis Chart - Sheet 1



AT-5 Fault Diagnosis Chart - Sheet 2

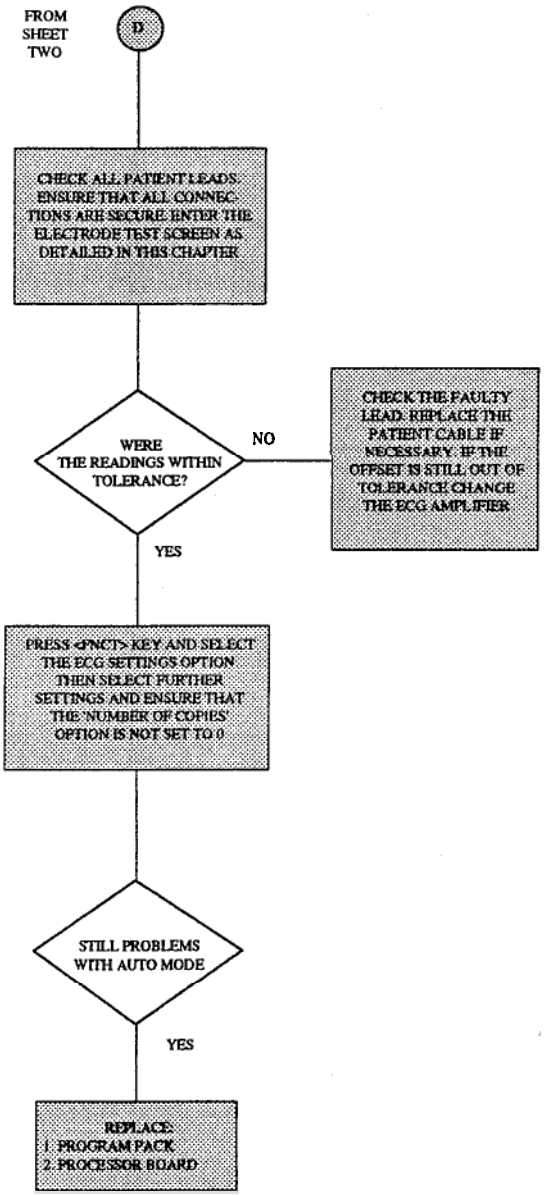


AT-5 Fault Diagnosis Chart - Sheet 3

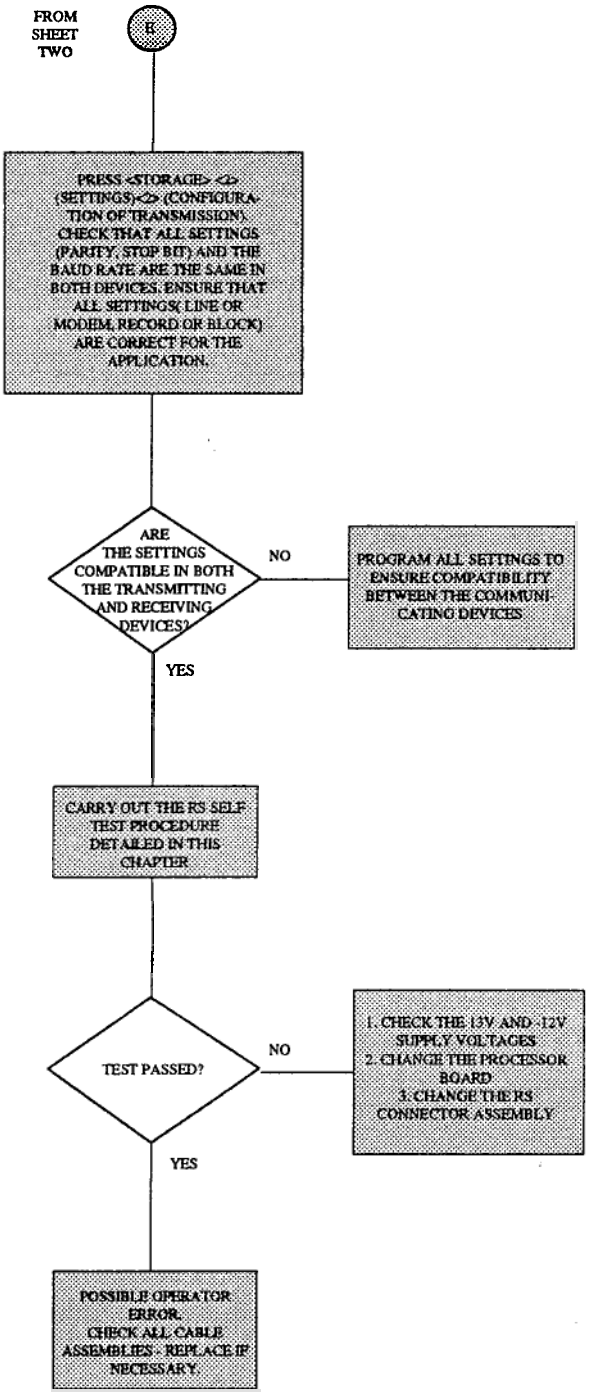


Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-5 Fault Diagnosis Chart - Sheet 4



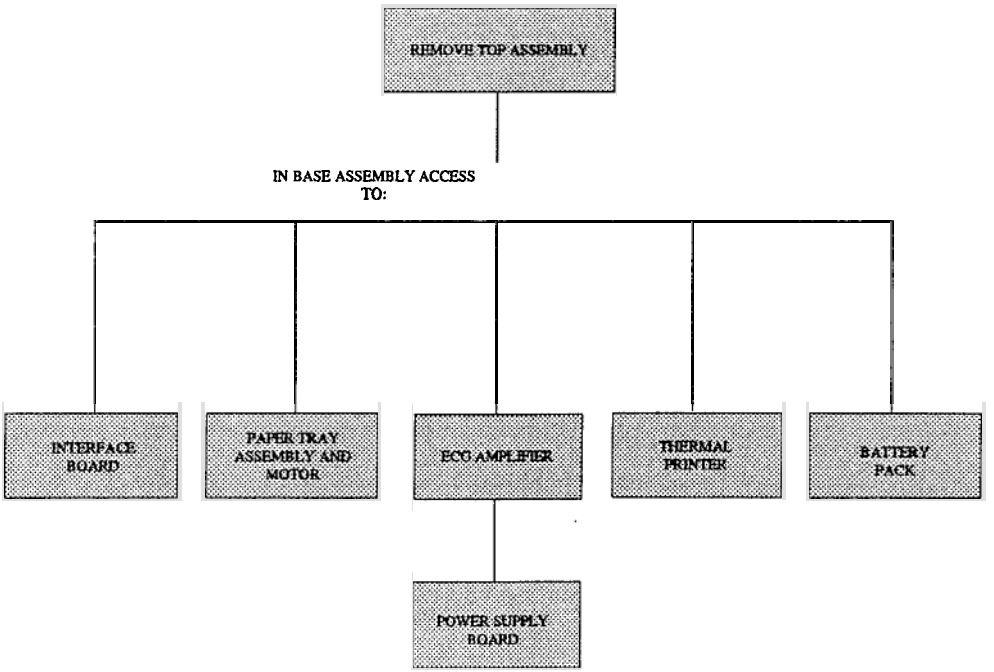
AT-5 Fault Diagnosis Chart - Sheet 5

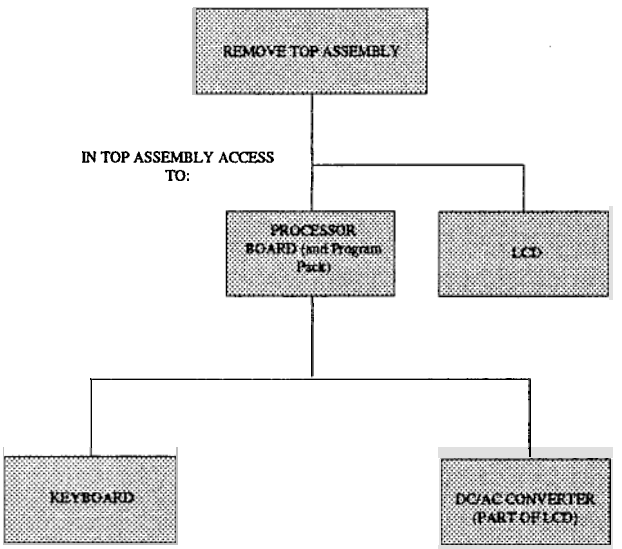


AT-5 Fault Diagnosis Chart - Sheet 6

Chapter 4
Physical Overview & Module Replacement

Contents





Note: The Program Pack is mounted on slides on the Processor board. The Program Pack can be changed via the Back Panel, without disassembling the unit, .
The DC/AC Converter board is mounted on the Processor board.

Introduction

This Chapter provides the procedures required to carry out the removal and replacement of all modules that are spared at service level. The instructions given in this chapter are autonomous, with each module containing the following:

- The pre-requisites that must be fulfilled before removing of the module
- Tools and equipment that are required to remove and replace the module and to carry out the functional checks and adjustments
- Removal Procedures
- Replacement Procedures
- Checks and Tests that must be carried out after replacement.

Any adjustments, jumper settings, special checks or functional procedures that are required during a procedure, are detailed in the relevant step.

In-text diagrams support the text where required and provide location details of connectors, test points and adjustment potentiometers.

Specific warnings and cautions are given where applicable. Warnings indicate potential danger that could cause personal injury. Cautions indicate areas that could cause damage to the equipment .

If a key operation or menu selection is required, the key sequence required is given in parenthesis `<>´. The character (or character string) given in parenthesis is the actual character that is printed on the key. When a key sequence is provided it must be followed in the order given.

Safety Notices

WARNINGS

BEFORE COMMENCING ANY REMOVAL OR REPLACEMENT PROCEDURES ENSURE THAT THE MAINS POWER SUPPLY IS SWITCHED OFF AND THAT THE MAINS CABLE IS REMOVED.

CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED AND WITH MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

THE AT-5 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS:

◊ WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT.

◊ PERSONNEL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS

◊ ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

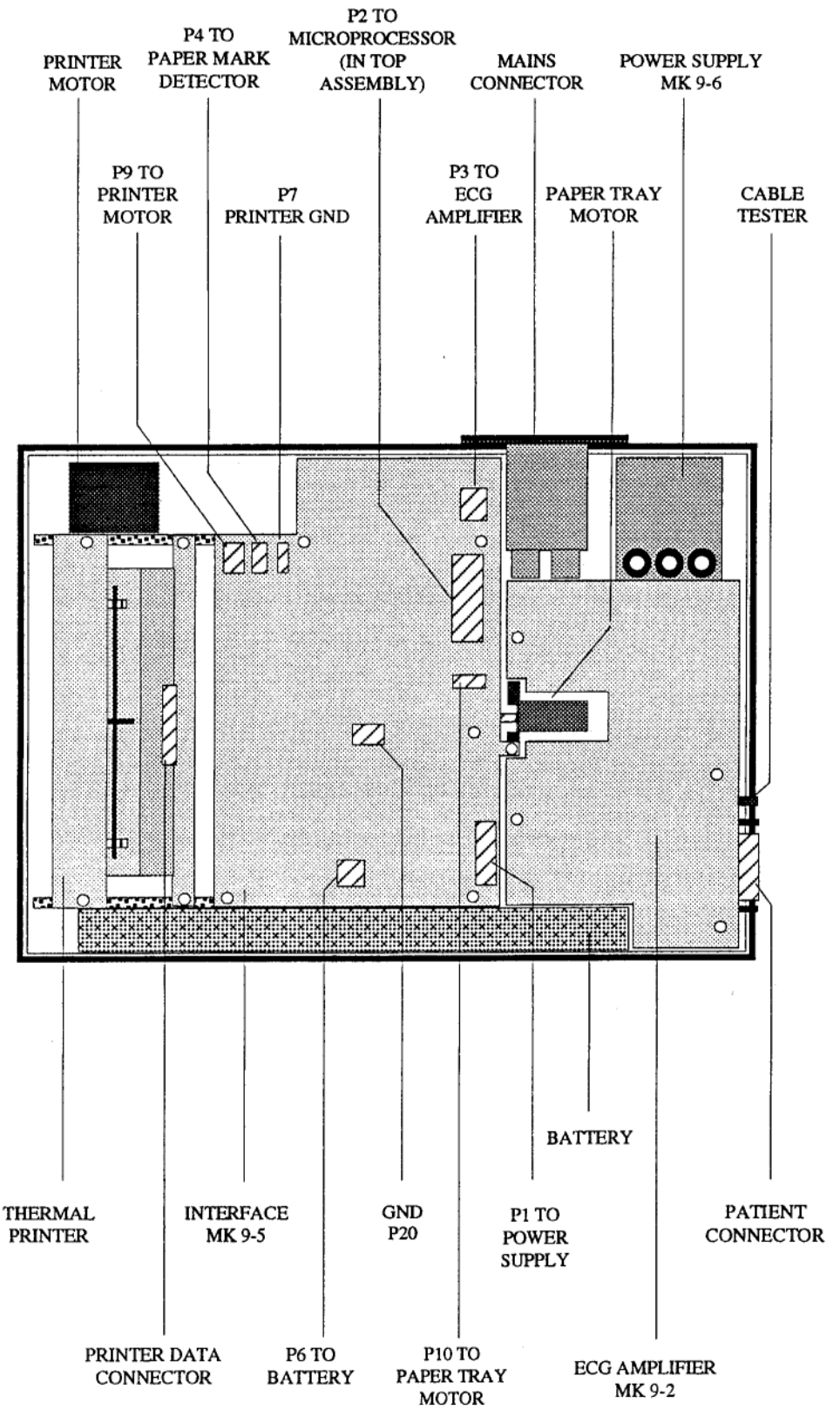
THE UNIT IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING, ALWAYS PLACE THE UNIT ON A SOFT, NON-ABRASIVE CLOTH WHEN CARRYING OUT MAINTENANCE PROCEDURES

TAKE CARE NOT TO PLACE ANY STRAIN ON THE CONNECTING RIBBON CABLE WHEN REMOVING THE TOP ASSEMBLY . ENSURE THAT THE CABLE ASSEMBLY IS NOT CRIMPED OR TWISTED AND THAT THE TOP ASSEMBLY IS NOT PLACED ON THE CABLE ASSEMBLY.

CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

THE PROCEDURAL STEPS GIVEN FOR EACH MODULE MUST BE FOLLOWED IN THE ORDER GIVEN.

Base Assembly



Base Assembly

The base assembly comprises a moulded plastic tray which contains the following:

- ◊ Rechargeable nickel-metal hydrid battery pack
- ◊ Power Supply Board MK 9-6
- ◊ ECG Amplifier Board MK 9-2
- ◊ Interface Board MK 9-5
- ◊ Paper Tray Assembly with Carriage Motor
- ◊ Thermal Printer

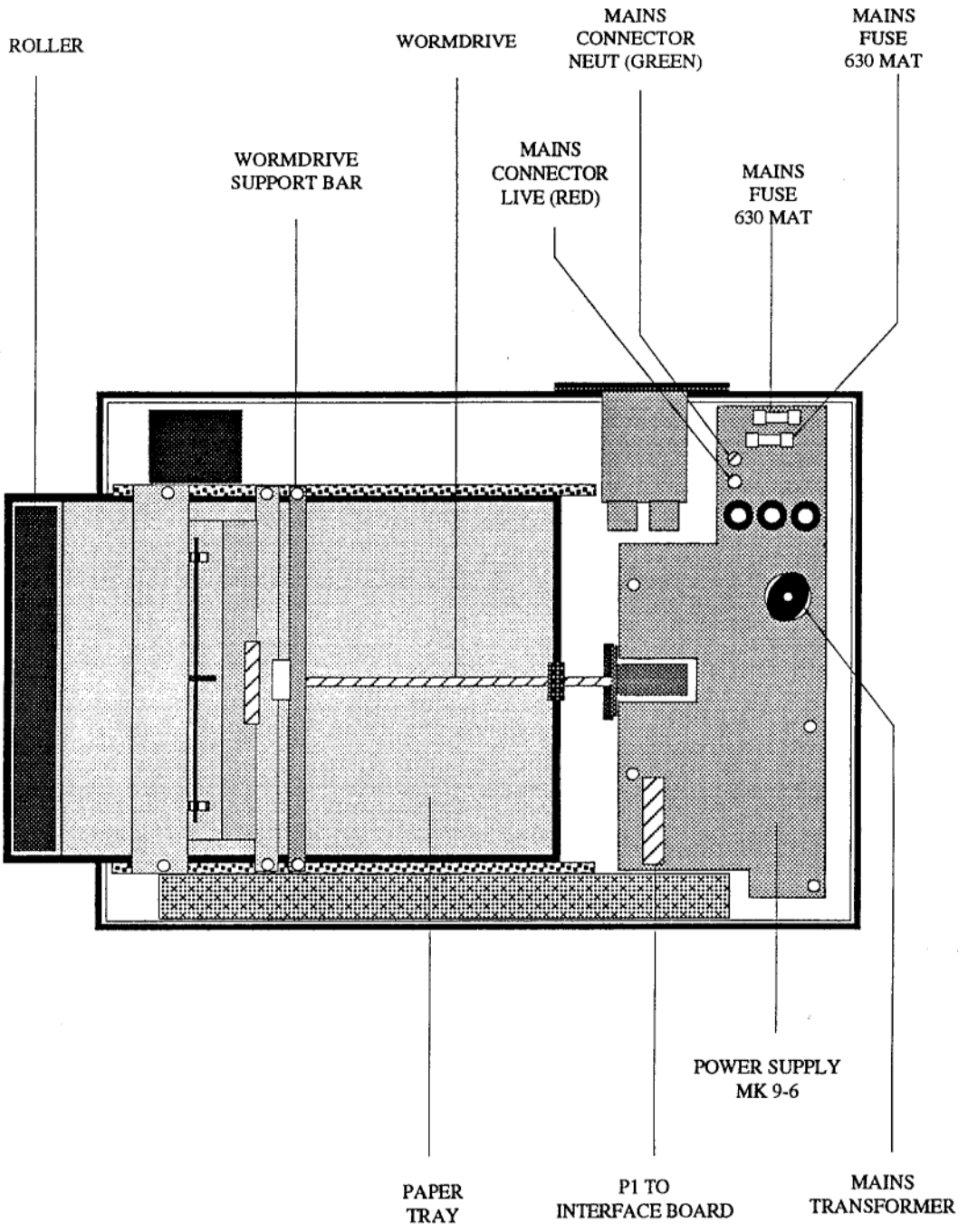
The Power Supply Board is secured to moulded tapped supports on the bottom of tray. The ECG Amplifier is mounted `component-side-down´, on four spacers above the Power Supply.

A cutout in the Base Assembly side panel allows access to the patient connector which is mounted directly on the ECG Amplifier.

The Interface board and the thermal printer are mounted on the two plastic paper tray guide rails screwed to the base.

Electrical connection between all boards and modules is achieved with ribbon cable assemblies or with flying leads.

Base Assembly



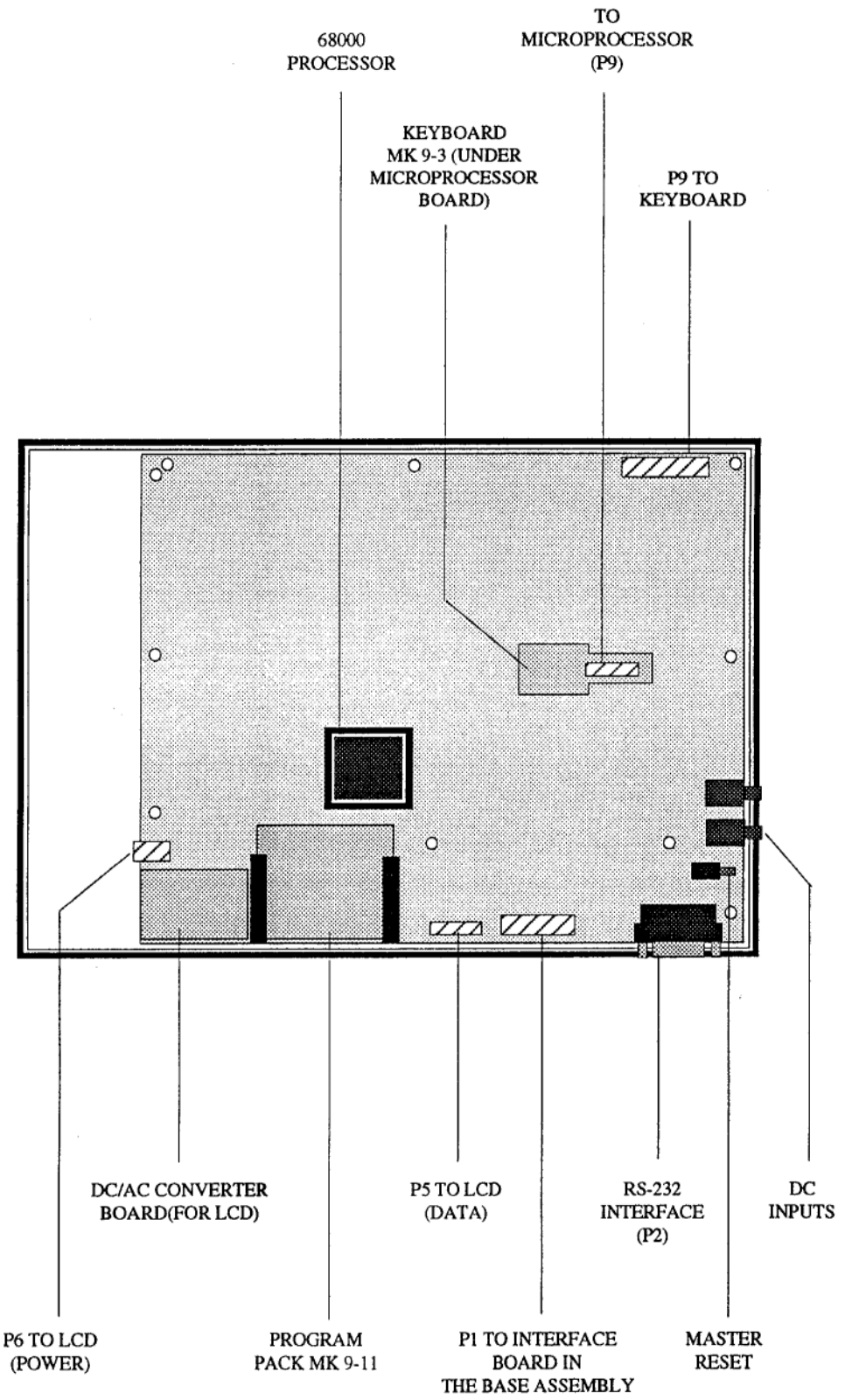
Base Assembly with Interface Board and ECG Amplifier Board removed.

Base Assembly (cont.)

The paper tray runs between two plastic guides. The dual rotation paper carriage motor, mounted on a securing plate screwed to the floor of the unit, turns a worm drive to slide the paper tray in or out.

The thermal printer motor is secured to the upper paper tray guide rail and only when the paper tray is retracted, connects with a toothed gear wheel to turn the paper roller.

Top Assembly



Top Assembly

The Top Assembly is manufactured from moulded plastic and comprises a Main Housing with a hinged LCD Assembly.

The assembly is recessed and allows the Keyboard to be mounted from the 'outside' to give a flush profile. The Processor board is secured on the inside of the unit. The Keyboard and the Microprocessor share some common fixations.

The Program Pack is inserted via a cutout in the back panel and is mounted in slides on the Processor Board. The DC input connectors and the RS connector are mounted directly on the Microprocessor board.

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Test Equipment, Tools, and Accessories

The following list details the tools, test equipment and accessories required to carry out all functional tests, calibration procedures and adjustments that can be carried out on the AT-5. The test equipment given here is general. A full list of test equipment and their part numbers are given in the previous Chapter. If specific recommendation for test equipment is required, please contact the SCHILLER service department.

- Digital Voltmeter
- Oscilloscope
- Frequency Counter
- Selection of cross-bladed, posi-drive and flat-bladed screwdrivers
- Cleaning agent such as Tricoetholine
- Torx hexagonal Allen Key 5mm (for Print Head)
- Selection of spanners
- Double-sided tape
- ECG Patient Simulator

Case Disassembly

Pre-requisites

- The unit must be placed on an anti-static mat and anti-static precautions observed when any maintenance is carried out on the AT-5. The room temperature should be between 18 and 28 degrees.
- Mains supply is required to carry out the unit functional test after assembly.
- THE WARNINGS AND CAUTIONS AT THE BEGINNING OF THE CHAPTER MUST BE OBSERVED.

Tools

- Posi-drive screwdriver

Test Equipment

The following test equipment is required to carry out the functional test after unit assembly

- SCHILLER Patient Cable
- Patient Simulator e.g. phantom 320.

Top Assembly Removal

The Top Assembly is mounted on the Base Assembly and is secured to the Base Assembly with six screws and washers; access to the screws is gained from the underside of the unit. To remove the Top Assembly, proceed as follows:

1. Remove any cable assemblies connected to the unit. Ensure that the mains cable is removed.
2. Taking care to secure the hinged LCD module so that it cannot swing open, turn the unit up-side-down and rest on a soft anti-static cloth.
3. Unscrew and remove the six countersunk retaining screws and washers situated in the extreme corners and edges of the unit.
4. Grasping the top and bottom of the unit to ensure that the two assemblies cannot part, carefully return the unit to the standing position.
5. Gently lift the Top Assembly sufficiently to gain access to the interconnecting cable, and disconnect the connector Interface board.
6. Gently lift the Top Assembly away from the Base Assembly and place on a soft cloth.

Case Assembly

Top Assembly Replacement

To replace the Top Assembly proceed as follows:

1. Check that all boards and components are firmly secured. Check for loose screws. Ensure that no screws or foreign bodies are loose in the bottom of the case.
2. Inspect all the internal cable assemblies and ensure that they are in good condition and that no visible damage can be seen. Ensure that no cable assemblies are strained, crushed or caught.
3. Ensure that all connectors are firmly home.
4. Position the Top Assembly adjacent to the Base Assembly and without straining the ribbon cable, plug in the interconnecting cable from the Top Assembly (Processor Board) to the Interface Board.

   Note: It may be necessary to tilt the Top Assembly for the cable assemblies to reach.

5. Carefully position the Top Assembly on the Base Assembly.
6. Grasping the two assemblies to ensure that they cannot part, carefully turn the unit up-side-down and replace the six securing screws and washers in the extreme corners and edges of the unit. Return the unit to the upright position.
7. Carry out the functional check procedure detailed at the end of this chapter.

ECG Amplifier Board

The ECG Amplifier is mounted above the Power Supply board and is secured to four spacers.

Pre-requisites

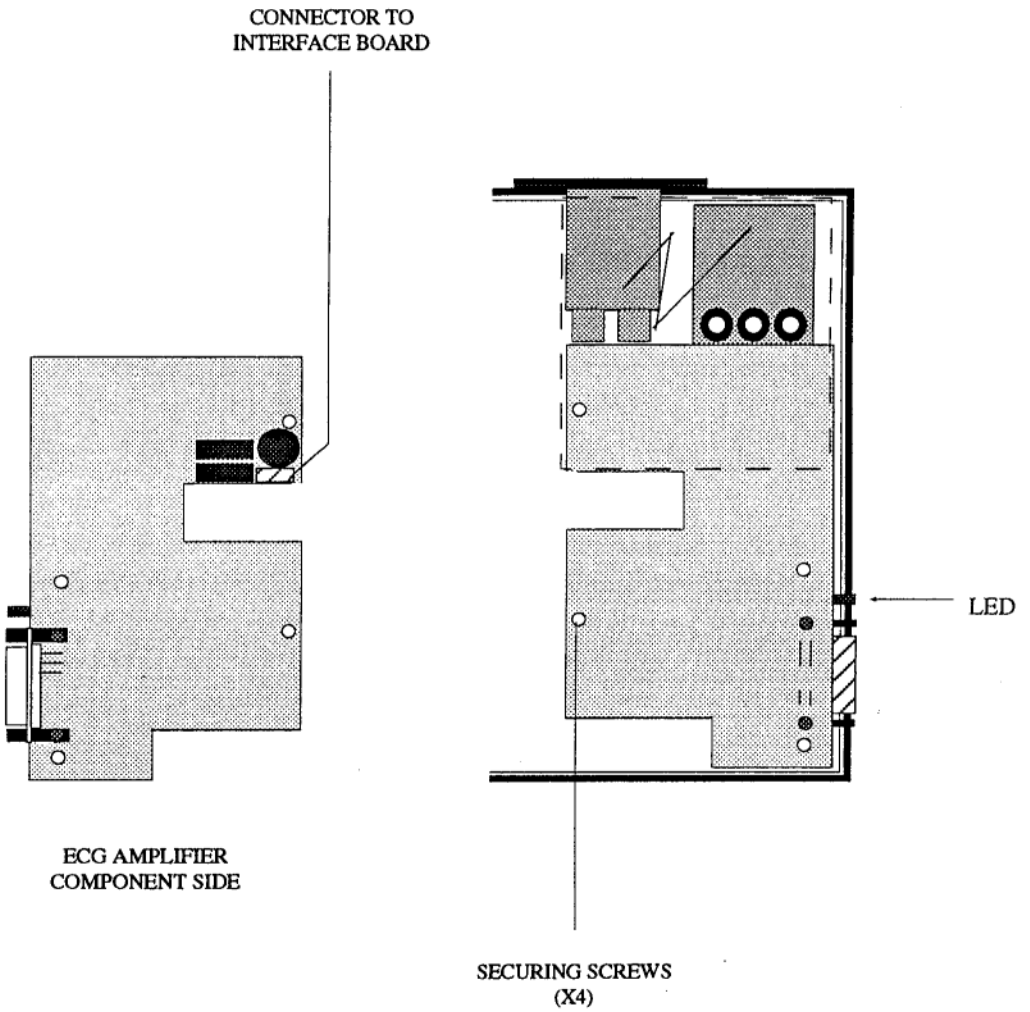
- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed and all external cable assemblies disconnected.

Tools and Test Equipment

- Cross-Bladed posi-drive screwdriver

Parts

ECG Amplifier board. Part number as detailed in Chapter 6.



ECG Amplifier Board

Board Removal

CAUTION

THE ECG AMPLIFIER CONTAINS STATIC SENSITIVE CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.

To remove the ECG Amplifier proceed as follows:

1. Disconnect the cable assembly to the Interface board and unscrew the four screws securing the board to the spacers. Remove the board.

Board Replacement

CAUTION

ENSURE THAT THE PLASTIC INSULATION PIECE IS INSERTED BETWEEN THE POWER SUPPLY AND THE ECG AMPLIFIER BEFORE SECURING THE ECG AMPLIFIER. SECURE THE INSULATION PIECE WITH DOUBLE SIDED TAPE TO THE MAINS CONNECTOR

1. Place the ECG Amplifier board component side down and slide into position so that the patient cable test point and LED fit into their respective cut-outs on the side panel. Take great care not to damage the LED.
2. Secure the board to the four spacer supports with the four retaining screws.
3. Connect the cable to the Interface board.

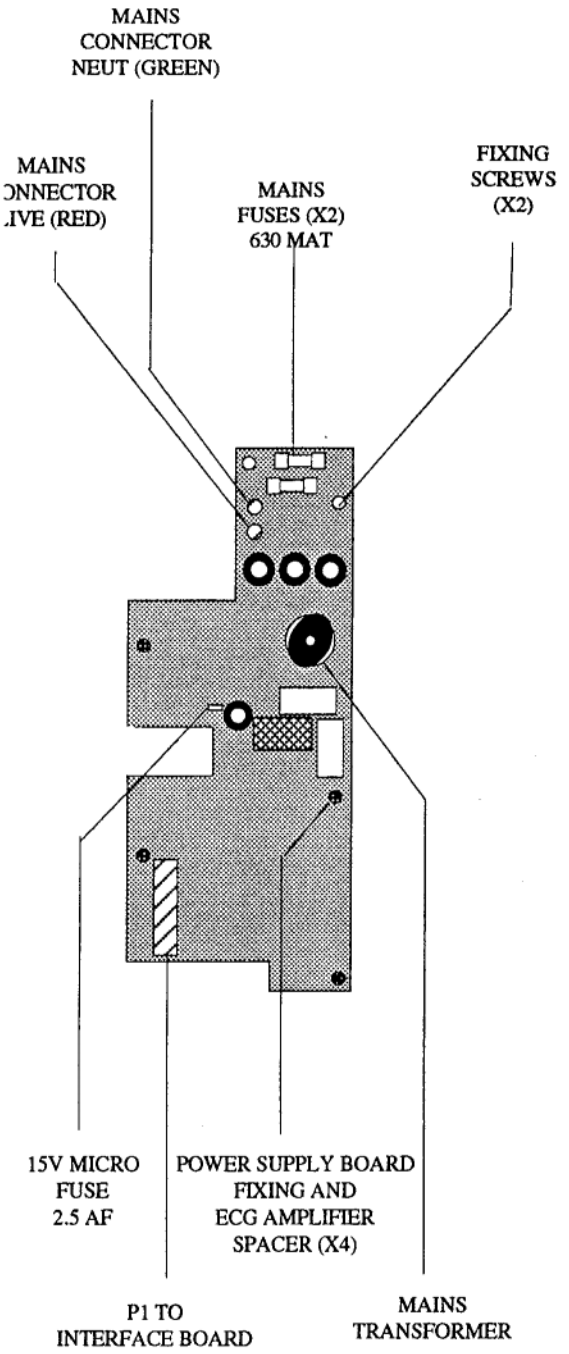
Checks and Tests after Replacement

To prove the integrity of the replaced board carry out the following functional check procedure:

1. Switch on the unit and connect a SCHILLER patient cable to the ECG connector. Carry out a cable test by inserting each lead into the lead test point. Ensure that the green test LED lights when a patient lead is inserted.
2. Connect a suitable patient simulator to the ECG connector and carry out a resting ECG. Ensure that all the leads can be displayed on the LCD.

Note: The procedure to carry out an ECG test is given in the AT-5 operating manual.

Power Supply Board



Power Supply Board

The Power Supply board is secured to the base tray and positioned under the ECG Amplifier board.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed
- The Top Assembly must be removed and all external cable assemblies disconnected.
- The ECG Amplifier must be removed

Tools and Equipment

- Posi-drive screwdriver
- Fixed hexagonal spanner (for spacers)
- Digital Voltmeter

Parts

Power Supply MK 9-6. Part number as detailed in Chapter 6.

Board Removal

WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

To remove the Power Supply board proceed as follows:

1. Disconnect the live and the neutral bayonet connectors to the mains connector (the power supplies connector to the ECG Amplifier will already have been removed as detailed in the previous paragraph).
2. Disconnect the ribbon cable connection (P1) to the Interface Board.
3. Unscrew the four spacer fixations, and the two fixing screws and remove the board.

Board Replacement

To replace the Power Supply proceed as follows:

1. Position the board and secure with the four spacers and two securing screws.
2. Connect the bayonet connectors to the mains connector.
3. Connect the ribbon cable to the Interface Board.
4. Replace the ECG Amplifier (detailed in the previous paragraph) and reassemble the unit.

Checks and Tests after Power Supply Board Replacement

After assembly, connect the mains supply to the unit and ensure that the green mains supply LED is lit. Switch the unit on and ensure that the LCD is lit and that meaningful data is displayed. Press the <PRINT SCREEN> key. Ensure that the printer functions.

Nickel Metal Hybrid Battery Pack

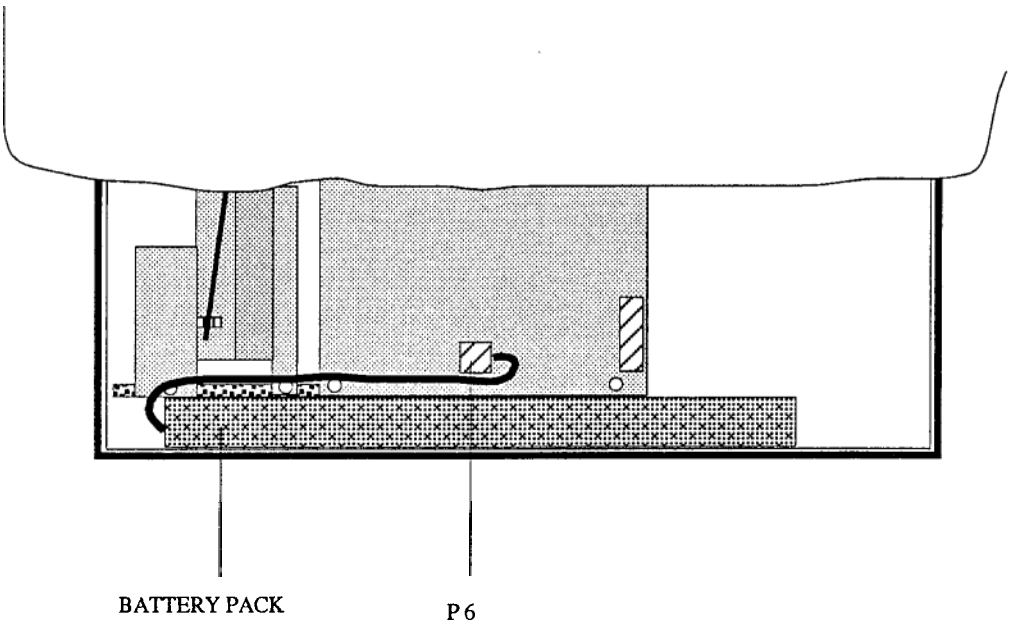
The battery pack is installed by the side of one of the paper tray runners and is held in position with double sided tape.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed and all external cable assemblies disconnected.

Parts

The part numbers of all replaceable items are given in Chapter 6.



Battery Pack Removal

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To remove the Battery Pack proceed as follows:

1. Ensure that the unit is switched off and that the mains is disconnected.
2. Disconnect the battery connector from the Interface board and remove the Battery Pack by gently pulling away from the paper tray runner.

Nickel Metal Hybrid Battery Pack

Battery Pack Replacement

1. Position the Battery Pack with the cable assembly at the 'printer end' and the double-sided tape attachment towards the paper tray.
2. Remove the double-sided tape protective sheet and secure the Battery Pack to the paper tray left-hand runner.
3. Connect to the socket on the Interface board

Checks and Tests After Battery Replacement

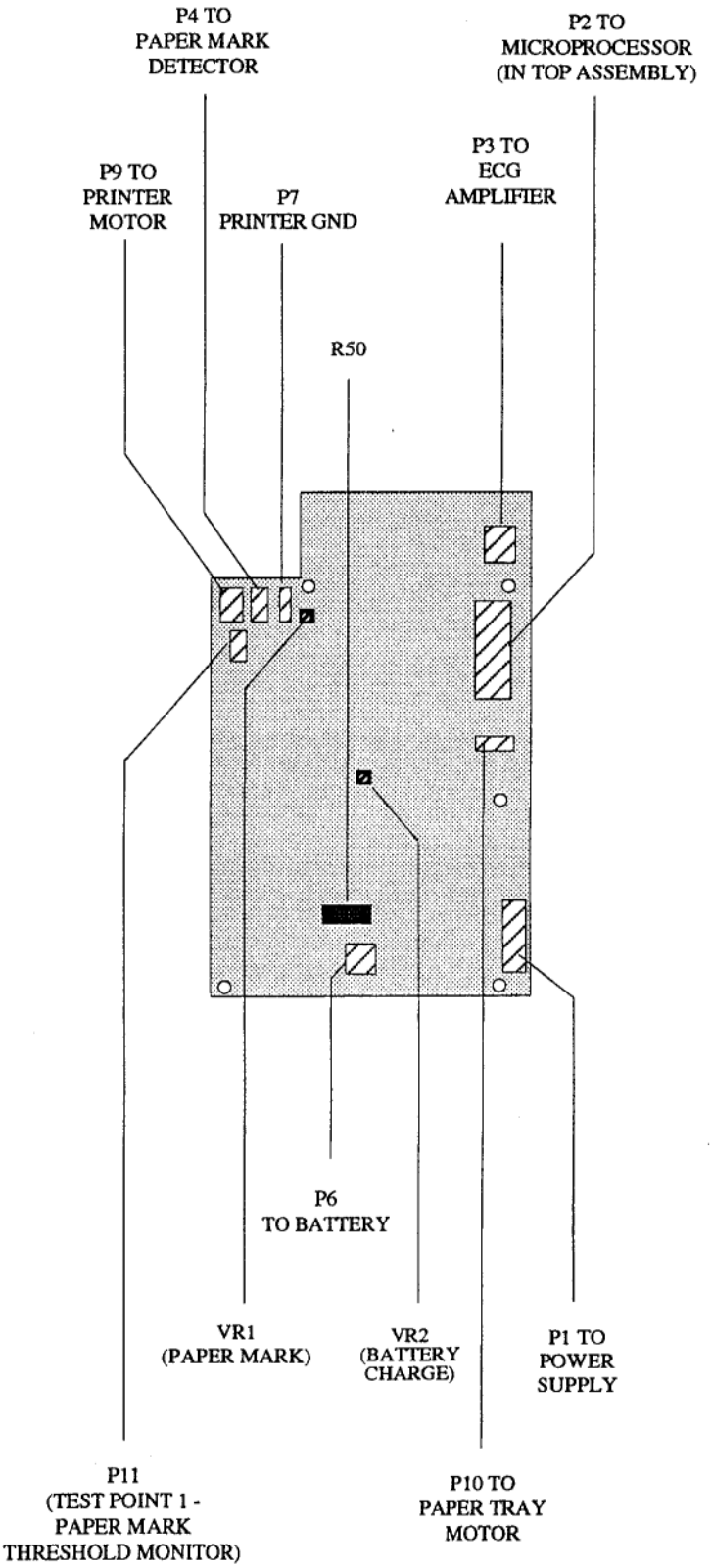
To ensure that the battery and the battery recharging circuit are functioning after battery replacement, proceed as follows:

1. Connect mains to the unit and ensure that the green mains and the yellow battery indicators, next to the display, are lit. Charge the battery for 1.5 - 2 hours. The battery has 90% capacity after 1.5 hours and is fully charged (100%) after 2 hours.
2. Ensure that the Battery indicator is extinguished after 1.5 - 2 hours (battery fully charged).
3. So that the capacity of the newly installed battery is calculated correctly by the processor, run the unit on battery power until the battery is fully discharged and the unit switches off. Repeat this process two times. This ensures that the correct capacity of the battery is registered by the processor. The calculated value of the battery capacity can be seen by pressing:

   <FNCT> <6> (electrode test) <ENTER> <ENTER>

   The B CAPACITY indication displays the calculated battery capacity. See Chapter 5 for further details.
4. Program all static settings which will have been lost when the battery was disconnected.

Interface Board



Interface Board

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed earlier and all external cable assemblies disconnected.
- The ECG Amplifier Board must be removed.

Tools

- Cross-bladed posi-drive screwdriver
- Small flat-bladed screwdriver

Parts

Interface Board MK 9-5. Part number as detailed in Chapter 6.

CAUTION

THE INTERFACE BOARD CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS

Interface Board Removal

The Interface board is mounted above the paper tray on the paper tray runners. To remove the Interface Board do the following:

1. Disconnect all connectors and the ground connector. The connection to the power supply board has to be disconnected at the power supply end of the cable.

2. Unscrew the five screws securing the board to the Paper Tray Assembly, and lift the board away from the Paper Tray Assembly.

Interface Board Replacement

To replace the Interface board position the board on the Paper Tray runners and secure using the five captive screws. Reconnect all connectors to the Thermal Printer and the Power Supply.

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Interface Board

Checks and Tests After Interface Board Replacement

The paper mark detection offset is set in the factory. If it is necessary to re-adjust the paper mark threshold proceed as follows:

1. Connect a digital voltmeter across the P11 connector (test point 1).

2. Switch the unit on and adjust VR1 to obtain a reading as follows:

   - > 3.5V when the black paper mark is under the paper mark detector
   - 0.4 to 0.5V when there is no paper mark under the detector i.e. white paper

   NB IF THE DETECTION DOES NOT RECOGNISE THE PAPER MARK AFTER ADJUSTMENT, ENSURE THAT THE PAPER MARK WINDOW IS CLEAN.

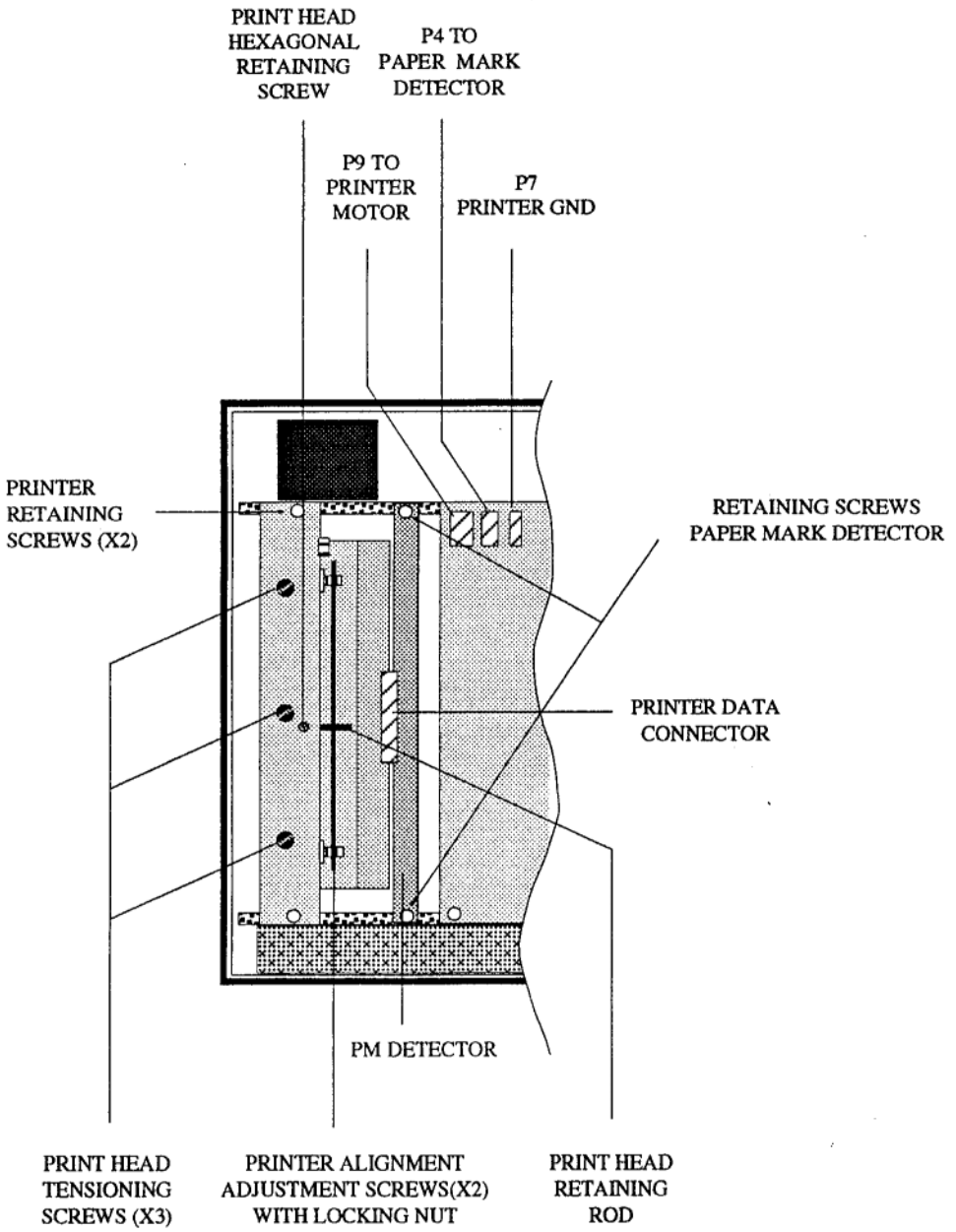
3. Carry out the printer check to ensure that the board is functioning correctly . Enter the following key sequence:

   <FNCT> <6> (electrode test) <P>

   A print-out of a series of diagonal lines will be given. Examine the print-out and ensure that all the lines are even and uninterrupted. Ensure that the complete paper is covered with close diagonal lines and that no blocks of plain paper are present. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print.

   Note: Unevenness of print or faulty individual pixels indicates a problem with the printer or printer alignment. If a complete block is left not printed it additionally indicates that the Interface board could be faulty or the fault lies with the printer data control circuits on the processor board.

Printer Assembly



Thermal Printer and Print Head

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2. All external cable assemblies must be disconnected.

Tools

- Cross-Bladed Screwdriver
- Flat-Bladed Screwdriver
- Hexagonal screwdriver Torx TX10
- Flat ended pliers

Part Numbers

The part number for the Thermal Printer and print head is given in Chapter 6.

CAUTION

THE THERMAL PRINTER CONTAINS STATIC SENSITIVE COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS:

Thermal Printer Removal

To remove the Thermal Printer disconnect all connectors to the Interface board, unscrew the two printer securing screws, gently lift the printer and remove the complete assembly.

Print Head Removal

To remove the Thermal Print Head after the printer assembly has been removed proceed as follows:

1. Slacken the three print head tensioning screws and remove the three springs and brass spacers.
2. Using the hexagonal screwdriver, slacken the hexagonal print head retaining screw and carefully remove the print head retaining rod with a pair of pliers
3. Gently ease the thermal print head away from the printer assembly.

Print Head Replacement

The Thermal Printer must be removed from the unit to replace the print head. To replace the print head in the printer assembly proceed as follows:

1. Remove the three print head tensioning screws. Assemble the three spring and brass spacers and insert the springs into the tensioning screws aperture so that the brass spacer adjoins the print head. Loosely fasten the three print head tensioning screws.
2. Carefully insert the print head retaining rod and secure with the hexagonal print head retaining screw.
3. Adjust the print head tensioning screws so that the head of the screws are indented and an even print head spring tension is achieved.

Thermal Printer and Print Head

Thermal Printer Replacement

The resistance value of the printer is used as an off-set by the printer drive circuit and must be entered via the AT-5 menu structure prior to operation. Before replacing the printer make a note of the printer resistance. The resistance value is found written on a label on the printer.

To replace the Thermal Printer proceed as follows:

1. Position the Printer and secure with the two retaining screws. Ensure that the cable assemblies from the printer to the Interface PCB are not caught and are not strained.
2. Reconnect the connectors to the Interface board.
3. Replace the Top Assembly.

Checks, Tests and Adjustments after Printer Replacement

Carry out the printer check as follows:

1. Check that the correct resistance of the printer is entered in the AT-5 memory as follows:

   Note: The printer resistance will be found on a label attached to the printer.

   ◊ Enter the following key sequence <FNCT> <6> (test electrodes) <ENTER> <ENTER>

   ◊ The resistance of the printer is now highlighted (R TPH). To enter a new resistance value press </>. The first figure of the resistance value is highlighted and the correct resistance value can be entered. Note that the AT-5 will only accept a resistance range of between 1000 and 1800 Ohms.

2. To check the printer and to ensure that every pixel is operational enter the test screen and press P. Enter the following key sequence:

   <FNCT> <6> (test electrodes) <P>

A print-out of a series of diagonal lines will be given. Carefully examine the print-out and ensure that all the lines are even and uninterrupted. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print. If the print intensity is uneven (for example darker at the top than at the bottom), check the alignment of the printer and adjust the tension of the print head (print head tensioning screws) to obtain the best print-out.

Paper Mark Detector

Pre-requisites

- The Warnings and Cautions at the beginning of the chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2. All external cable assemblies must be disconnected.
- The printer assembly has to be removed.

Tools

- Cross-Bladed Screwdriver

Part Numbers

The part number for the Paper Mark Detector is given in Chapter 6.

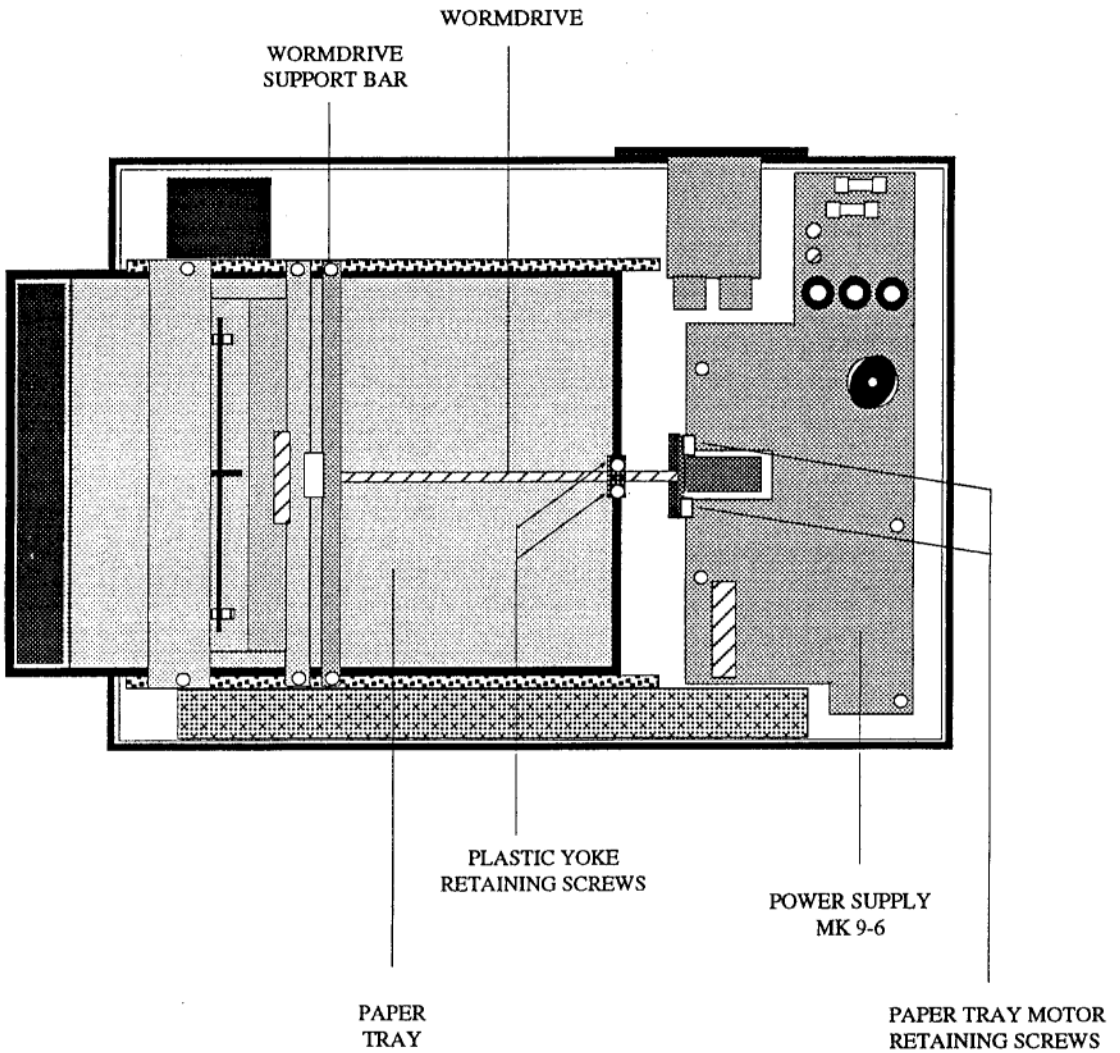
PM Detector Removal

1. Disconnect the Paper Mark Detector from the interface board.
2. Unscrew the two screws retaining the Paper Mark Detector to the paper tray guide rails.
3. Gently remove the detector.

PM Detector Replacement

1. Put the PM detector in place and secure it to the paper tray rails with the two retaining screws.
2. Connect the PM detector to the interface board.

Paper Tray Motor & Wormdrive



Paper Tray Motor & Wormdrive

Pre-requisites

- The Warnings and Cautions at the beginning of the chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2. All external cable assemblies must be disconnected.
- The interface board and the ECG amplifier board must be removed.

Tools

- Cross-Bladed Screwdriver

Part Numbers

The part numbers for the spare parts are given in Chapter 6.

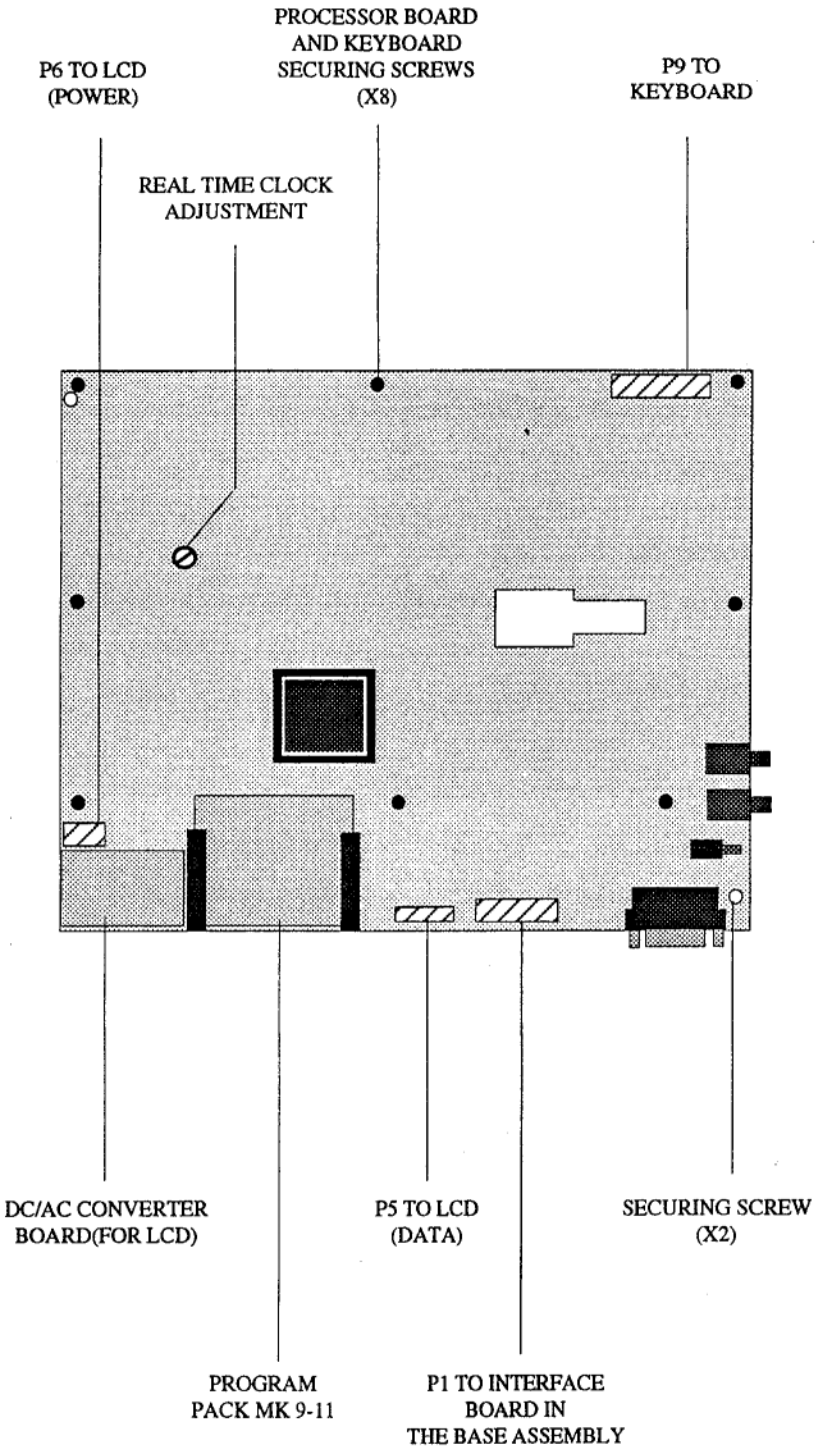
Motor and Wormdrive Removal

1. Remove the two crews securing the wormdrive support bar to the paper tray guide rails and gently remove the bar.
2. Unscrew the two screws from the plastic yoke coupling the worm drive to the paper tray.
3. Remove the two screws holding the Motor to the metal fixture and carefully remove the motor with the wormdrive.

Replacing Motor and Worm Drive

1. Put the motor with the wormdrive in place and secure it to the metal fixture.
2. Slide the plastic yoke along the wormdrive until it can be secured to the paper tray.
3. Slide the wormdrive support bar in place and secure it with the two screws.

Microprocessor Board, Keyboard and Program Pack



Microprocessor Board, Keyboard and Program Pack

The Microprocessor board and Keyboard are secured in the Top Assembly on opposite sides of the assembly. The holding screws are common to both boards. The Processor board has an additional two screws to hold it to the frame. The Processor board must first be removed before the Keyboard can be removed; likewise, the Processor board cannot be installed without the Keyboard.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed previously and all external cable assemblies disconnected.

Tools

- Cross-Bladed posi-drive screwdriver

Parts

- Microprocessor Board MK 9-1. Part number as detailed in Chapter 6.
- Keyboard MK 9-3. Part number as detailed in Chapter 6.

Microprocessor Board and Keyboard Removal

CAUTION

THE MICROPROCESSOR BOARD AND THE PROGRAM PACK CONTAIN CMOS COMPONENTS. ANTI-STATIC PRECAUTIONS MUST BE OBSERVED AT ALL TIMES

To remove the Processor board proceed as follows:

1. Close the LCD screen and place the Top Assembly on the closed LCD screen so that the Processor board is 'face-up'
2. Disconnect all the connectors to the LCD (connector to the Base Assembly is already removed) and unscrew the eight plus two screws securing the Microprocessor board in position.
3. Gently remove the board taking care not to catch the delicate cable assemblies to the LCD and the Keyboard.

The Program Pack is mounted in slides on the Microprocessor board and connects directly with it. To remove the Program Pack gently prise the Program Pack away from the Processor board.

To remove the Keyboard:

1. Position the Top Assembly so that the LCD screen is uppermost; open the LCD screen.
2. The Keyboard holding screws will have been removed when the Processor board was removed and the Keyboard can now be withdrawn.

Microprocessor Board, Keyboard and Program Pack

Microprocessor Board and Keyboard Replacement

The Keyboard must be replaced before replacing the Microprocessor board. To replace the Keyboard and Microprocessor boards proceed as follows:

1. Place the Top Assembly in the upright position with the LCD screen up. Place the keyboard in the keyboard recess.
2. Close the LCD. Turn the Top Assembly up-side-down.
3. Place the Microprocessor board in position taking care to ensure that the cable assembly from the LCD is not caught. Run the keyboard data cable assembly between the keyboard and the Processor board.
4. Plug in the connector on the Processor board **before securing** the board.

   Note: The LCD cable assemblies (power and data) are also close to the edge of the board and can also be connected at this point. Take care not to strain the cable assemblies when connecting.

5. Secure the Processor board and the keyboard with the six retaining screws. Replace the two additional Microprocessor screws.
6. Slide in, and secure the Program Pack if removed.
7. Replace the Top Assembly on the Base Assembly.

   Note: The EEPROM software contains several language versions, which are available in the System Settings. To set the proper language proceed as follows:

   <FNCT> <8> (System settings) <4> (Device configuration) <4> (Set language)

   By pressing key 4 several times, the following language versions can be selected:

   English

   French

   Swedish

   American

   Italian

   German

Microprocessor Board, Keyboard and Program Pack

Checks and Tests After Microprocessor Board Replacement

When the unit is reassembled after replacing the keyboard or the Microprocessor board, the functional check detailed at the end of this Chapter must be carried out to ensure the integrity of the assembled unit.

The capacity of the battery is calculated and stored by the processor for reference. To recalculate and store the correct battery capacity proceed as follows:

1. Fully charge the battery by leaving the unit connected to the mains for 2 hours. The battery is 90% full after 1.5 hours and fully charged after 2 hours.

2. Run the unit on battery power until the battery is fully discharged and the unit switches off.

3. Repeat this process two times.

The value of the battery capacity calculated (and stored) by the processor, can be seen by pressing:

<FNCT> <6> (electrode test) <ENTER> <ENTER>

The B CAPACITY indication displays the calculated battery capacity. See Chapter 5 for further details.

If the Program Pack has been replaced check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display is present on switch-on.

The software version can be checked (to ensure that it is the same as written on the label)as follows:

<FNCT> <6> (Electrode test) <.> (period)

(See Chapter 5 for software details).

If the keyboard has been replaced enter the patient data screen by pressing <PATIENT DATA> and systematically press each of the keyboard characters. Check the LCD and ensure that the correct characters are displayed as entered.

LCD Removal

The LCD comprises the LCD screen and an DC/AC Converter PCB (mounted on the Processor board). The LCD is secured with double sided tape and held in position with the hinged LCD casing.

Pre-requisites

- The replacement of the LCD must be carried out under clean room conditions.
- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed and all external cable assemblies disconnected.

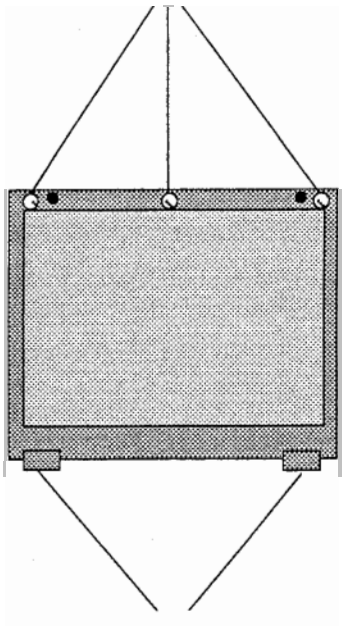
Tools and Disposables

- Cross-Bladed Screwdriver
- Long shafted cross-bladed screwdriver
- Flat-bladed blunt knife
- Anti-static cleaning fluid (alcohol based) and clean cleaning cloth

Parts

The part number for the LCD assembly is given in Chapter 6.

LCD STOPS AND COVER
RETAINING SCREWS
(UNDER)



LCD HINGES

LCD Removal

LCD Removal

To remove the LCD proceed as follows:

WARNING

HIGH VOLTAGES ARE GENERATED IN THE LCD. ENSURE THAT THE MAINS IS DISCONNECTED BEFORE REMOVING THE LCD HOUSING COVER.

1. Close the LCD screen and turn the Top Assembly up-side-down.
2. Remove the connector to the DC-AC Converter PCB on the Microprocessor board and the data connector. Return the Top Assembly to the upright position.
3. Using a flat-bladed knife or a small screwdriver remove the three LCD stops on the top of the LCD to gain access to the screws securing the LCD housing cover.
4. Unscrew the three screws and gently ease the cover away from the LCD hinges at the bottom.

CAUTION

THE RIBBON CABLE TO THE LCD DOES NOT HAVE A CONVENTIONAL PLUG AND IS INSERTED DIRECTLY INTO THE SIDE OF THE CONNECTOR ON THE LCD. TAKE CARE NOT TO DAMAGE THE RIBBON CABLE CONTACTS WHEN REMOVING THE RIBBON CABLE. TAKE SPECIAL CARE WHEN REPLACING THE CABLE ASSEMBLY.

5. Lift the retaining tape from the LCD connector on the back of the LCD and remove the ribbon cable to the LCD/Buffer Board.
6. Very gently and evenly prise the LCD away from the case until it is free. Take care not to strain the ribbon cable.

   Note: The DC/AC converter board for the LCD is situated on the Processor board. If this needs replacing it must be unsoldered.

LCD Replacement

LCD Replacement

To replace the LCD proceed as follows:

1. Ensure that the LCD recess is clean and free from grease, dirt, and any traces of adhesive. Use a clean cloth and alcohol based cleaning agent to wipe the recess to ensure a good adhesion surface.
2. Position the LCD in the casing and thread the ribbon cable and the power cable through the aperture in the Top Assembly casing.
3. Join the connectors at the back of the LCD and carefully tape to the LCD.
3. Using a flat-bladed knife peel off the protective backing from the two sided tape on the LCD and secure the LCD Assembly in the LCD recess.
4. Taking care not to touch the plastic screen, position the cover in the LCD bottom hinges and secure with the three retaining screws at the top. Replace the LCD stops in the screw recesses.
5. Replace the connectors to the Microprocessor board.

Checks after LCD Replacement

1. After assembly, connect mains to the unit and switch on. Ensure that the mains LED lights.
2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads. Ensure that the `information box´ in the top right-hand corner of the display is clearly defined and that all characters are correctly formed.
3. Enter the patient data screen by pressing <PATIENT DATA> and systematically press each of the keyboard characters. Check the LCD and ensure that the correct characters are displayed as entered.

Functional Check

Functional Check After Assembling the AT-5

The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test and is only intended to ensure that all the main functional areas of the AT-5 are operational after a unit has been reassembled. If any check fails, reference must be made to Fault Diagnosis Chapter 4.

Equipment Required

- SCHILLER Patient Cable
- Patient Simulator e.g. phantom 320.

Functional Check

To carry out the general confidence check proceed as follows:

1. Switch the mains on and ensure that the green mains LED lights.
2. Switch the unit on by pressing the <ON> key on the Keyboard. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display is present.
3. Press <FNCT> select the system setup option, and enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen.
4. Connect the ECG phantom to the ECG connector on the side panel and switch the phantom on. Ensure that a good ECG trace is displayed on the screen.
5. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality.
6. Press the <PATIENT DATA> key and systematically press the keys:

   <QWERTZUIOP>, <ENTER>, <1234567890>

   Ensure that the entered data is presented on the screen as entered. Press <ESC> to exit from the patient data display.
7. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out). Switch the unit off and leave connected to the mains supply for 2 hours to fully charge the battery. Ensure that the Battery LED is extinguished when the battery is fully charged.
8. Disconnect the mains power supply and leave the unit for 2 hours. Switch the unit on and check that the battery LED lights. Ensure that all static parameters have been remembered. Leave the unit switched on for 45 minutes (without using the printer) and check that the battery LED does not start to flash in that time.

Chapter 5
Functional Checks & Adjustments

Contents

Check and Adjustment Procedures

General Confidence Check

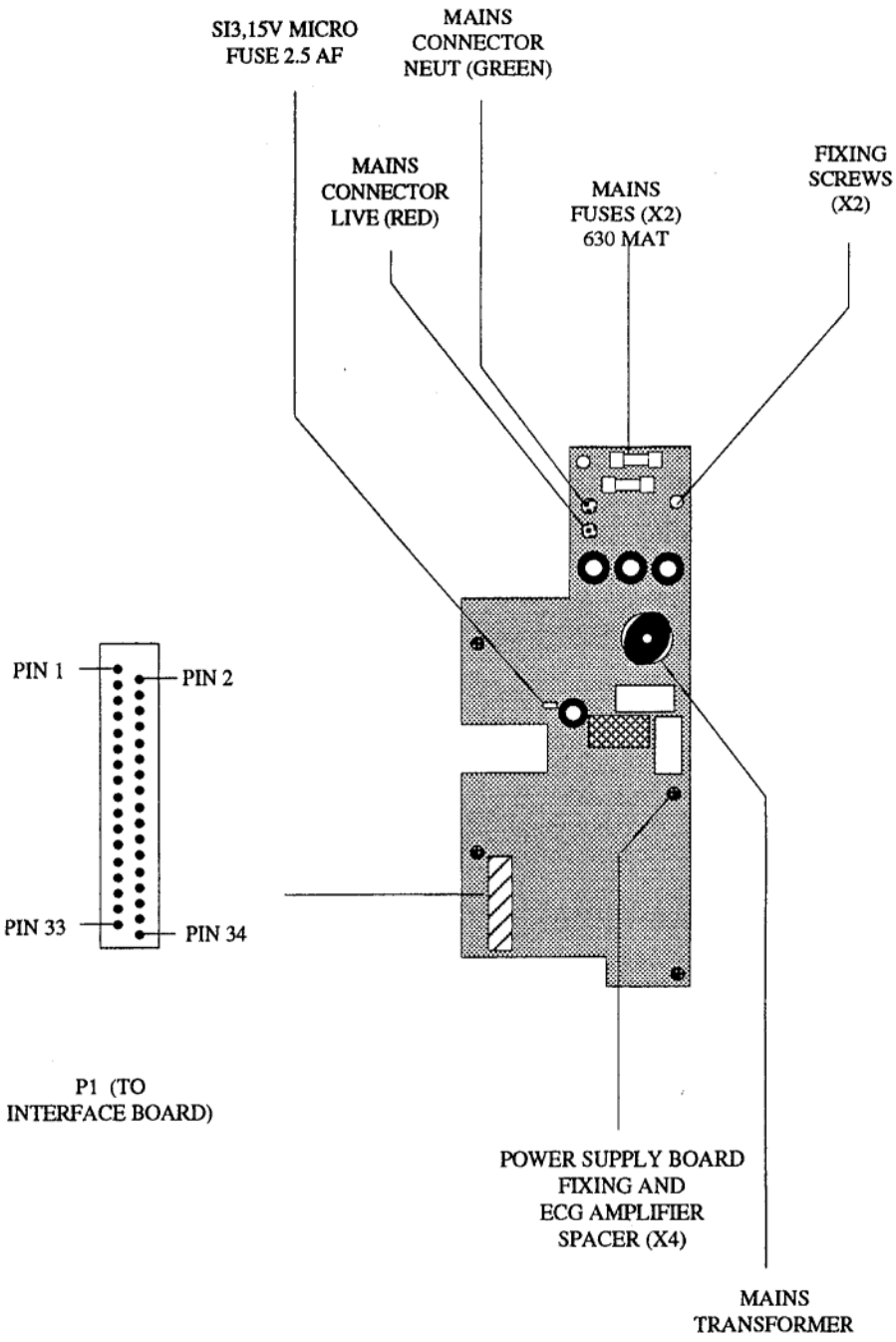
The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test (which can only be carried out with dedicated equipment in the factory) but is intended to provide a general confidence check in all the major AT-5 functional areas. The instructions given here are guides to the basic functions. If more operating information is required (general settings, comprehensive menu guides etc.) please refer to the relevant User Manual for the software version applicable.

To carry out the general AT-5 functional check procedure, proceed as follows:

1. Connect mains power to the unit and ensure that the green mains LED lights.
2. Switch the unit on by pressing the <ON> key on the keyboard. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.
3. Press the <FNCT> and select 'System Settings' and 'Date and Time' options. Enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen in the information box.
4. Press the <REPLACE PAPER> key. Ensure that the paper tray extends and retracts smoothly.
5. Carry out the Printer Check detailed in this Chapter.
6. Carry out the RS test with a test plug detailed in this chapter
7. Connect an ECG simulator to the ECG connector on the side panel and switch on. Ensure that a good ECG trace is displayed on the screen.
8. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality. Press <MAN START> and ensure that the print-out is accurate and of good quality.
9. Press the <AUTO START> key and wait approximately 10 seconds for the printout to commence. Ensure that the print-out is accurate and of good quality.
10. Press the <PATIENT DATA> key and systematically press the keys:

    <QWERTYUIOP>, <ENTER>, <1234567890>

    Ensure that the entered data is correctly presented on the screen as entered. Press <ESC> to exit the patient data display.
11. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out).
12. Switch the unit off and leave connected to the mains supply for 2 hours to charge the battery (1.5 hours 90%, 2 hours 100% charge). Ensure that the Battery LED flashes when charging and extinguishes when the battery is fully charged.
13. Disconnect the mains and switch the unit on. Ensure that the Battery LED is lit. Run the unit on battery power for approximately an hour. Ensure that the battery LED flashes when the battery has limited capacity (not before 45 minutes).
14. Repeat steps 12 and 13 twice so that the processor can calculate the capacity of the battery.


SI3,15V MICRO
FUSE 2.5 AF
MAINS
CONNECTOR
NEUT (GREEN)
MAINS
CONNECTOR
LIVE (RED)
MAINS
FUSES (X2)
630 MAT
FIXING
SCREWS
(X2)
PIN 1
PIN 2
PIN 33
PIN 34
P1 (TO
INTERFACE BOARD)
POWER SUPPLY BOARD
FIXING AND
ECG AMPLIFIER
SPACER (X4)
MAINS
TRANSFORMER

Power Rail Measurement

The power supply voltages can only be checked in isolation. It is not possible to check the power rails in situ. Individual adjustment is not possible for any of the voltage rails and if any of the voltage supplies are not correct, the power supply must be changed.

Equipment Required

- Voltage Generator
- Digital Multimeter

WARNING

DISCONNECT THE MAINS SUPPLY BEFORE COMMENCING

CAUTION

OBSERVE ANTI STATIC PRECAUTION

Procedure

To check the power supply rails, proceed as follows:

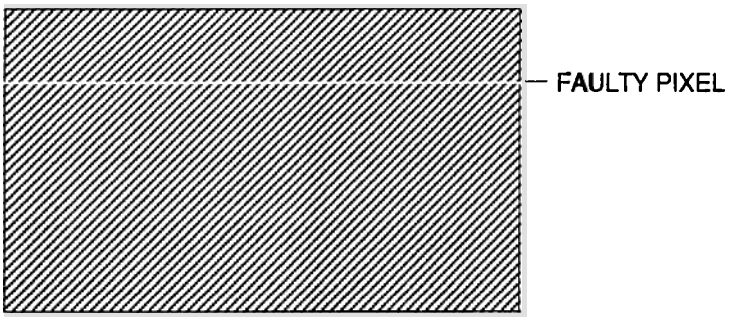
1. Disconnect the mains supply.
2. Remove the Top Assembly and the ECG Amplifier board as detailed in Chapter 5.
3. Remove the P1 connector to the Interface board and connect the voltage generator to any pin between pin 21 and pin 26. Set the voltage to +15V.
4. Measure the voltages at plug P1.

   Note: The battery charge regulation circuit is situated on the Interface board. The adjustment procedure to set the charge current is given later in this chapter.

Printer

To check the printer and to ensure that every pixel is operational, a built-in printer test is provided. To carry out the printer check enter the following key sequence:

<FNCT> <6> (Electrode test) <P>



A print-out of a series of diagonal lines will be given. Carefully examine the print-out and ensure that all the lines are even and uninterrupted. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print.

If a faulty pixel is detected the printer must be replaced. If the print-out is uneven (for example darker at the top than at the bottom), it indicates that the printer alignment is not correct. If the print-out is too faint or too dark, check that the correct resistance is entered in memory as detailed following.

IMPORTANT: THE 'SHELF LIFE' OF THE PRINTER PAPER IS NOT INDEFINITE. OLD PAPER, PAPER THAT HAS NOT BEEN STORED IN A COOL DAMP FREE ENVIRONMENT, OR PAPER THAT HAS BEEN EXPOSED TO EXCESSIVE HEAT CAN ADVERSELY EFFECT THE QUALITY OF THE PRINT-OUT. ENSURE GOOD QUALITY PAPER IS USED.

Printer Resistance

Check that the correct resistance of the printer is entered in the AT-5 memory as follows:

Note: The printer resistance will be found on a label attached to the printer.

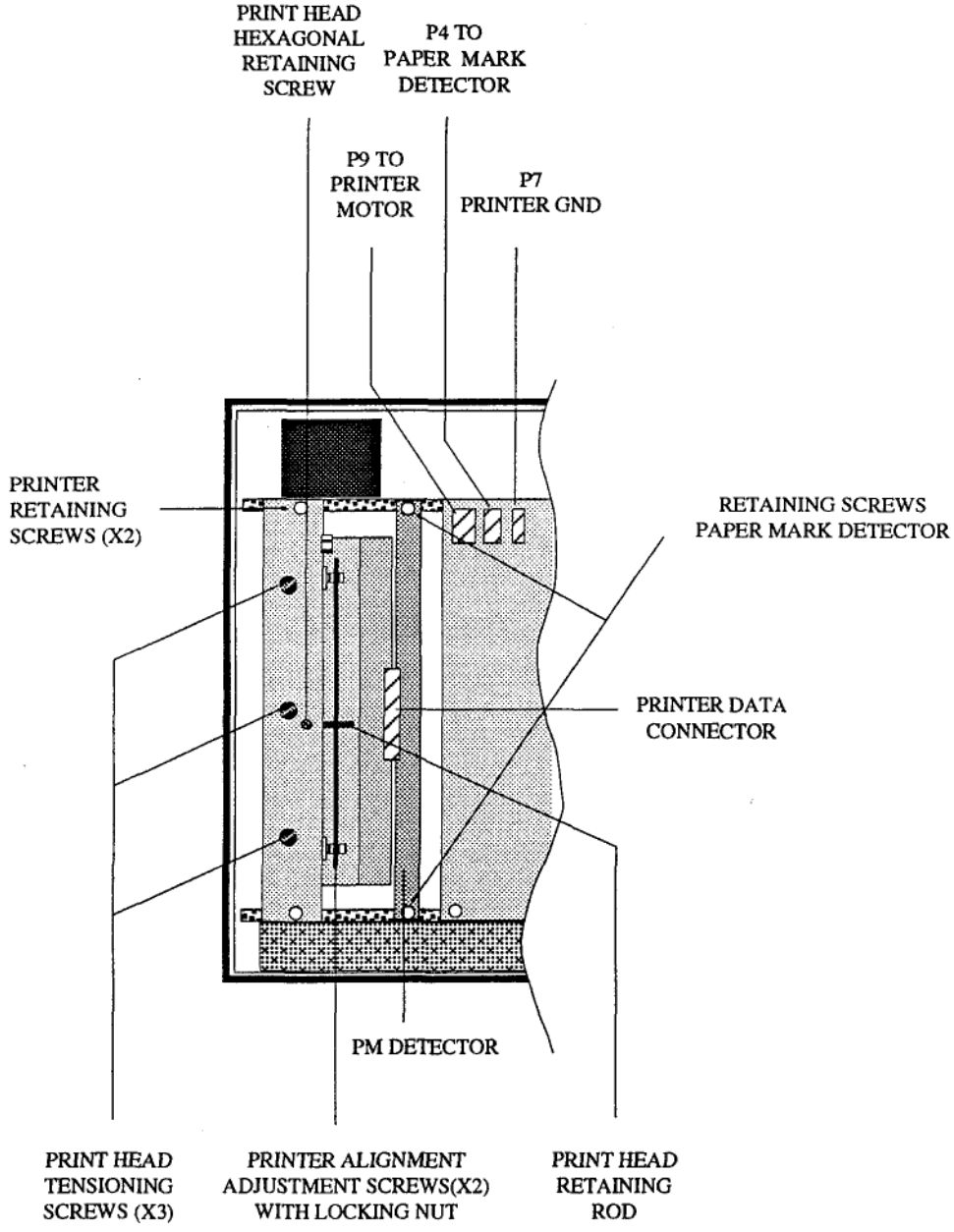
1. Enter the following key sequence <FNCT><6> (Electrode test) < ENTER> <ENTER>
2. R TPH is the resistance of the printer. To enter a new resistance value press </>. The first figure of the resistance value is highlighted and the correct resistance value can be entered. When the correct resistance value has been entered, press <ENTER> to save the setting. Note that the AT-5 will only accept a resistance range of between 1000 and 1800 Ohms.

Print Head Alignment

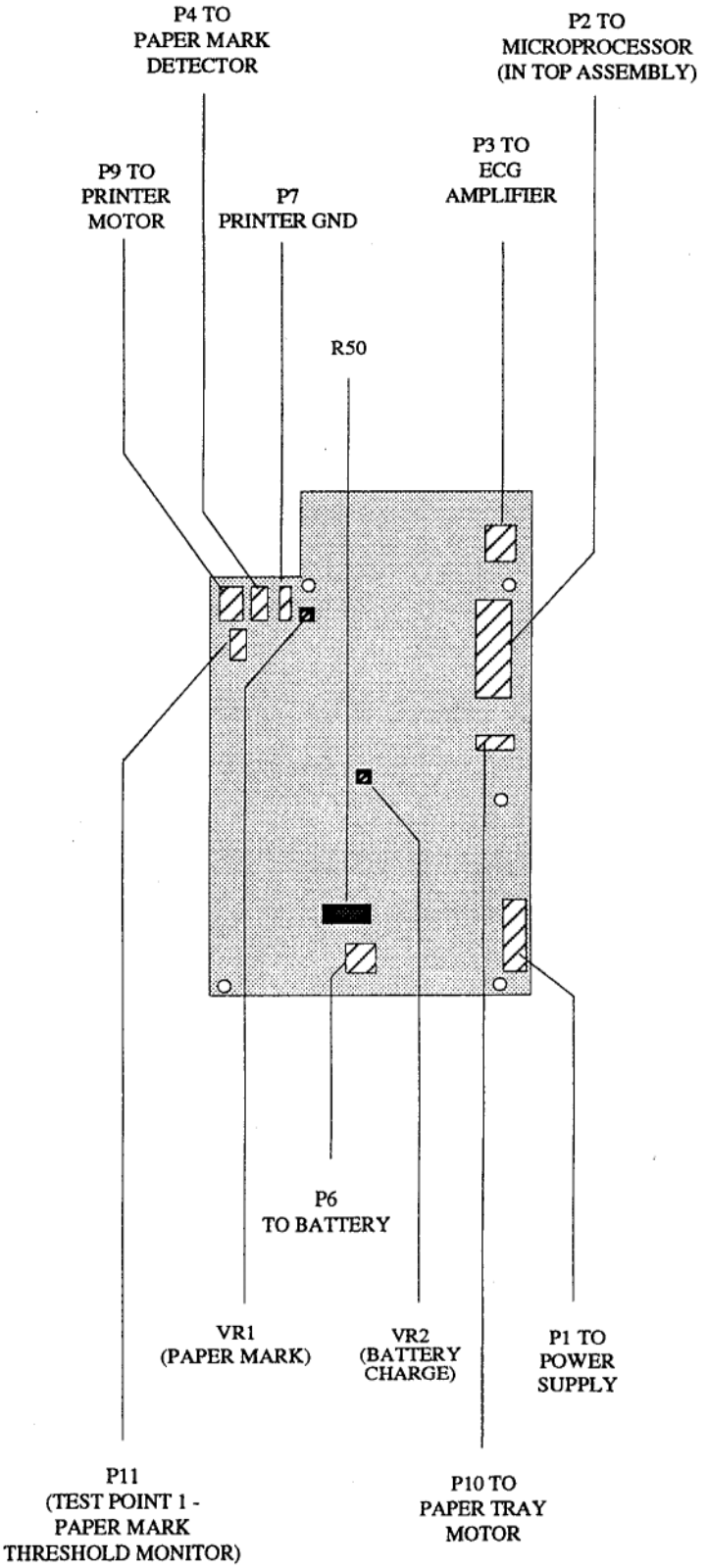
Print Head Alignment and Print Head Tension

The print head tension (the pressure that the print head exerts on the printer paper) is achieved with the three spring loaded print head alignment screws. Adjust the screws so that they are slightly indented below the frame to achieve the best quality print-out.

Print head alignment is set with two alignment adjustment screws. Adjust to achieve correct alignment. Lock with the locking nuts when correctly adjusted.



Paper Mark Threshold



Paper Mark Threshold

Interface Board Paper Mark Threshold and Battery Charge Current Adjustments

Both the paper mark detection circuit and the battery charge regulation circuits are on the interface board. Both of these adjustments must be carried out with the Top Assembly placed above the Base Assembly and still connected electrically. To remove the Top Assembly proceed as follows:

WARNING

ENSURE THAT THE MAINS CABLE IS REMOVED

1. Taking care to secure the hinged LCD module so that it cannot swing open, turn the unit up-side-down and rest on a soft anti-static cloth.
2. Unscrew and remove the six countersunk retaining screws and washers situated in the extreme corners and edges of the unit.
3. Grasping the top and bottom of the unit to ensure that the two assemblies cannot part, carefully return the unit to the standing position.
4. Taking care not to strain the connecting cable assembly between the Top and Base Assemblies, gently lift the Top Assembly and place above the Base Assembly with the LCD open.

Paper Mark

The paper mark circuit is on the Interface board. This pre-set is used to adjust the paper mark detection circuit threshold so that the paper mark is recognised. The paper mark is used for calculation of print-out commencement position, paper detection, paper present etc.

Paper Jammed Indication

When the detection circuit does not recognise the paper mark, a paper jam message may be displayed. Before carrying out the paper mark adjustment procedure, ensure that the paper detector window is clean.

Set the paper mark threshold as follows:

1. Connect a digital voltmeter across the P11 connector (test point 1).
2. Switch the unit on and adjust VR1 to obtain a reading as follows:
   - > 3.5V when the black paper mark is under the paper mark detector
   - 0.4 to 0.5V when there is no paper mark under the detector i.e. white paper

NOTE IF THE DETECTION DOES NOT RECOGNISE THE PAPER MARK AFTER ADJUSTMENT, ENSURE THAT THE PAPER MARK WINDOW IS CLEAN.

Battery Charge Current

Battery Charge Current Offset

The battery charge circuit offset can only be set when the battery is discharged. To set the battery charge current, proceed as follows:

1. Run the unit on battery power until the battery is discharged and the unit switches off.
2. Remove the Top Assembly and place above the Base Assembly as previously detailed.
3. Connect a digital voltmeter across R50.

WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THE BATTERY CHARGE CURRENT. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENT.

4. Connect mains to the unit and adjust VR2 to achieve a voltage reading across R50 of 17.5mV (equating to a charge current of 0.7A (resistance 0.25Ω)).

RS Interface Testing

RS Interface Error messages

The following error messages are associated with the RS Interface. If any of these error messages are displayed, carry out the checks suggested.

DATA SET NOT READY	This indication appears if no signal is received from the remote unit (after approximately 30 seconds). ° Check that the remote unit is switched on and set to the correct parameters ° Check the correct set-up in both units (<STORAGE> key) ° Check that the connecting cable is correctly plugged in ° Check the integrity of the cable assemblies (at both units) ° If using a modem ensure that it is communicating with the remote modem
TRANSMISSION ERROR	This is a general fault indication ° Check that the remote unit is switched on and set to the correct parameters ° Check that the connecting cable is correctly plugged in ° Check the integrity of the cable assemblies (at both units) ° If using a modem, ensure that it is communicating with the remote modem
NO FILE FOUND	An ECG transmission has been attempted, but no ECG is stored in the units´ memory. Store an ECG in the memory and attempt the transmission again. If the same message appears, change the Processor board.

RS Self Test

RS Self Test with Test Plug

The RS interface self test ensures that the RS communication circuit on the Processor board is functioning. This is done by transmitting a signal and sending the signal directly back to the unit via the test plug. To carry out the RS self test proceed as follows:

Note: If the SCHILLER test plug is not available a test plug can easily be fabricated from an standard 9-pin D-Type plug.

The following pins must be wired

- ◊ pins 2 and 3 (receive/transmit)
- ◊ pins 7 and 8 (RTS/CTS)
- ◊ pins 6 and 4 (DSR/DTR(ready))

1. Connect the RS test plug (Part number to be assessed) to the RS port on the rear of the unit
2. Switch the AT-5 on. Press the <STORAGE> key and then select the Test Mode option and self test with test plug (T).

The self test starts and a pass or fail message appears on the LCD. An audible indication is given that the test is complete.

Test Failure

If this test fails ensure that the test plug is wired and connected correctly (if fabricated). If the test cable assembly is correct, a fault is indicated on the Processor Board or Power Supply (±12V supply).

Test Pass

When this test passes it indicates that the fault lies in the remote equipment, the transmission line or that the protocol of the two communicating devices are incompatible.

- Check that all settings (Parity, Stop bit) and the Baud rate are the same in both devices.
- Reset all settings to ensure compatibility between the communicating devices. Check that all settings (Line or Modem, Record or Block) are correct for the application. Are the settings compatible in both the transmitting and receiving devices?
- Check the integrity of all cable connections. Are all cables correctly connected to the programmed port?

RS-232 PIN CONNECTIONS	
PIN	SIGNAL
3	OUT (DATA OUTPUT)
2	IN (INPUT DATA)
7	RTS1 (OUTPUT - REQUEST TO SEND)
8	CTS1 (INPUT - CLEAR TO SEND)
6	DSR1 (INPUT - RECEIVE UNIT READY)
4	DTR1 (OUTPUT - TRANSMIT UNIT READY)
5	GROUND

RS-232 Transmission/Reception Test

Settings

The Baud rate (B) can be set with the '+'(YES) and '-'(NO) keys, the parity (P) with key P and the number of stopbits (S) with key S.

Test Input / Output

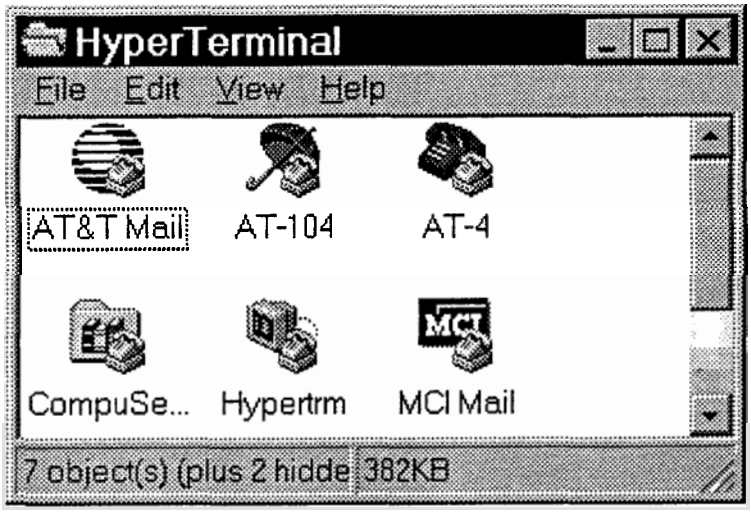
The test transmission / test reception options enables a test sequence to be generated and received. Use these test options to ensure that the receiving and transmitting units can communicate and that the cable assemblies, connectors etc. between the communicating units are good.

The test message generated is a string of all ASCII characters - ABCD.... 1234....abcd... etc. When the test transmission / reception option is selected, the string of characters sent by the transmitting unit are displayed on the LCD in the receiving unit. In the transmitting unit a message is displayed indicating that a test transmission is in progress.

To perform these tests, you will need a second AT-5 unit, or the AT-5 RS-232 interface has to be connected to an active terminal, for example the Hyperterminal, which is available under Windows 95™. The following equipment is needed:

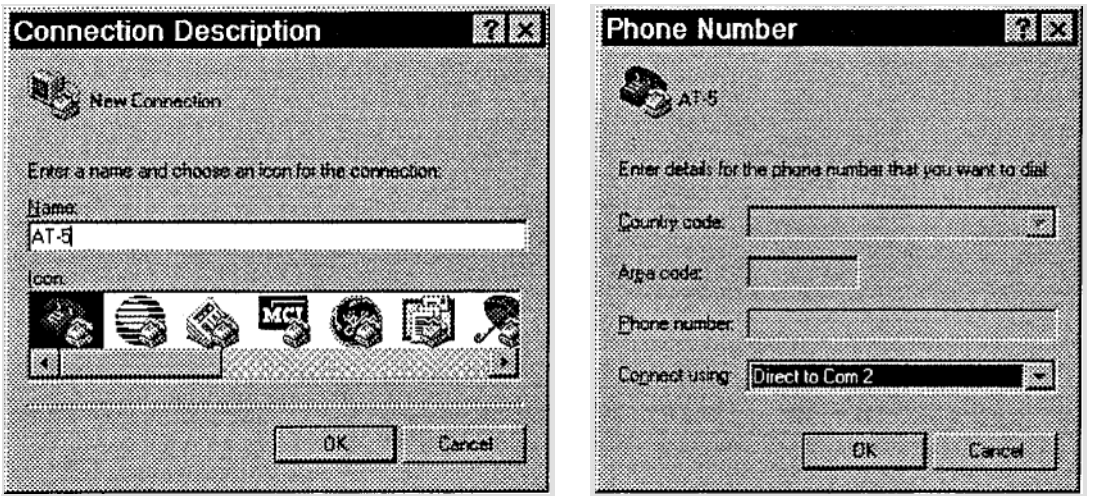
- A personal computer (PC) with Windows 95™ Hyperterminal installed.
- An RS-232 cable assembly, Art.No. 2.310 159, for connecting the RS-232 interface on the AT-5 with the COM port of the PC.

1. Start from Windows 95 desktop. Click on START. Select Programs / Accessories / Hyperterminal.

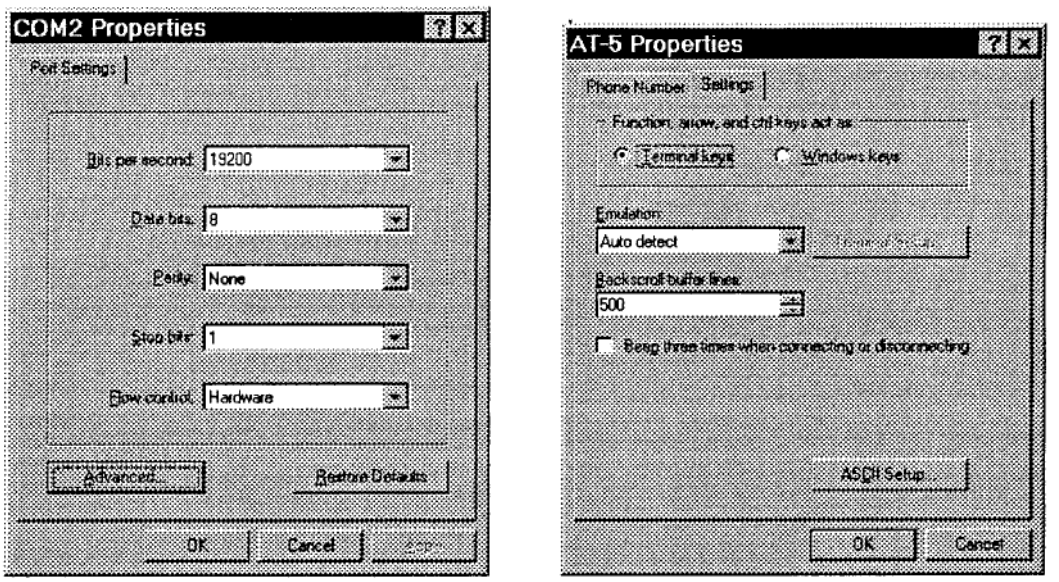


2. Double-click on Hypertrm(.exe). Enter the name AT-5 for the new connection and click on OK.

RS-232 Transmission/Reception Test

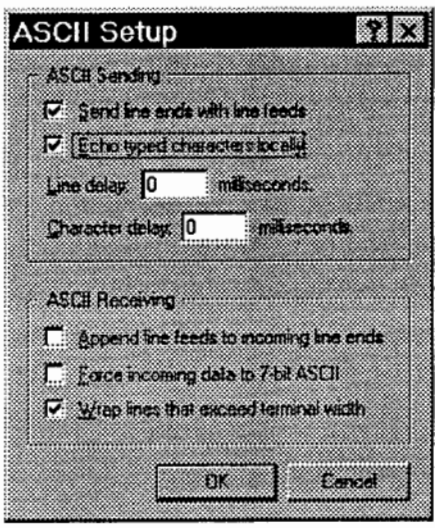


3. Set the direct connection to the proper COM-port and click OK.
4. Enter the port settings 19200, 8, N, 1, Hardware and confirm with OK..



5. You are now in the AT-5 Hyperterminal window. Click on File and select Properties.
6. Go to tab Settings and set Terminal keys, Auto detect and 500 buffer lines.
7. Click on ASCII Setup.

RS-232 Transmission/Reception Test

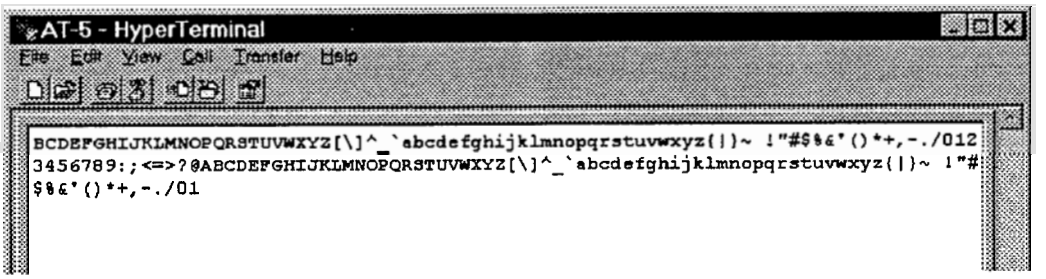


8. Check the boxes for "Send line ends with line feeds", "Echo typed characters locally" and "Wrap lines that exceed terminal width". Confirm with OK. Click once more on OK to get back to the open Hyperterminal window.

You are now ready to start the input and output tests.

Test Output

- On the AT-5, press the <STORAGE> key and select Test mode. Make sure that the settings are 19200 bps, parity N, stopbit 1.
- Press key "O" (Output) on the AT-5.
- The AT-5 now sends a string of alphanumerical characters, which are echoed in the Hyperterminal window on the PC.

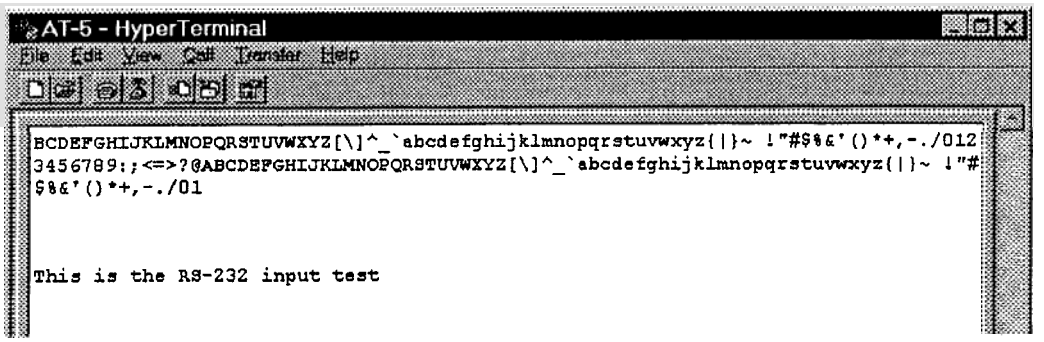


- Stop the test by pressing key "Q" (Quit).

RS-232 Transmission/Reception Test

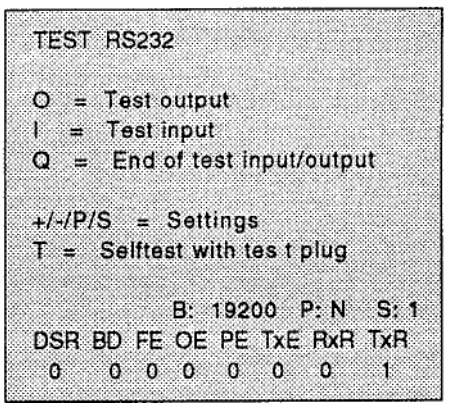
Test Input

- In the RS-232 test window, press the key "I" (Input). The upper part of the RS-232 test window is erased to be able to display incoming messages.
- On the PC, type any characters and verify that they are echoed on the AT-5.



- Stop the test by pressing key "Q" (Quit). Leave the RS-232 test window by pressing ESC.

Error Codes



The error codes shown at the bottom of the display have the following interpretations:

DSR	Data set ready
BD	Break detected
FE	Frame error
OE	Overrun error
PE	Parity error
TxE	Transmitter empty
RxR	Receiver ready
TxR	Transmitter ready

Self Test Screens

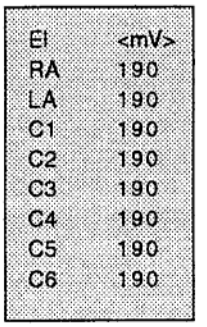
There are three test screens built into the AT-5 for use by the service engineer. The first screen provides test information of the patient cable and electrode application. The second screen gives the value of certain reference voltages and important internal synchronisation measurements and the third screen gives variable settings and measurements. The first two screens are for information only, and no adjustment can be made to these values. Additional test equipment is required to carry out some of the settings on the third screen. The three test screens are as follows:

Electrode Test Screen	This screen indicates the electrode offset voltage and can indicate any faults in the patient cable or patient electrode.
Self Test Screen	This screen displays ECG internal reference voltages and internal measurements of synchronisation and other parameters.
Offset Settings Test Screen	This provides measurements of some the analog offsets and contains the thermal print head resistance setting option.

Electrode Test Screen

Use this screen to display the dc voltage between the left leg electrode and all other electrodes. The measurements obtained will indicate any cable short circuits or open circuits. To enter the electrode test screen proceed as follows:

1. Press <FNCT> to display the main menu options.
2. Select option `Electrode Test´ to enter the electrode test screen. The following display will be shown:



The measured voltage value will depend on where the electrodes are connected. The voltage readings that can be expected are as follows:

- With patient connected ± 100mV.
- With patient simulator connected ± 30 mV - this will depend on the patient simulator used and must be taken as a flexible measurement.
- With all electrodes shorted together: ± 10 mV.
- Patient lead not connected i.e. open circuit > -320 mV.

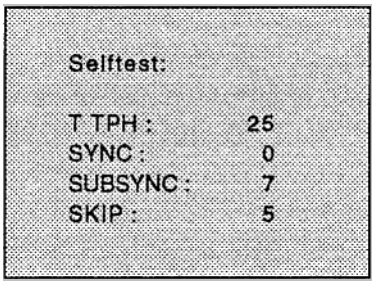
Note: The readings obtained with this screen are necessarily arbitrary. Generally when the readings for all electrodes are the same, or vary by only a small percentage, it can be assumed that the patient cable and electrodes are within tolerance.

Self Test Screen

To enter the self test screen proceed as follows:

1. Press <FNCT> <6> (electrode test) <ENTER>.

The following display will be shown:



This screen gives the following data:

T TPH

This is the temperature of the print head heat sink. This measurement is used by the CPU to control the printer timing to obtain optimum print. The reading given here should be approximately the ambient temperature of the room. Note that if the printer has recently been active this reading may be higher than the room temperature.

SYNC

This value is a counter reading of the number of communication failures between the ECG Amplifier and the main CPU, since the unit was switched on. There should never be any communication failures and this value should be 0. If communication failures are occurring it indicates a problem with the ECG Amplifier board or the Processor board.

SUBSYNC

This counter gives the number of times that re-synchronisation of the data subvector has occurred. On initial switch on this counter could read 5 to 30. After initial synchronisation this figure should not increase. If re-synchronisation is occurring, check the optical link between the Processor board and the ECG Amplifier board.

SKIP

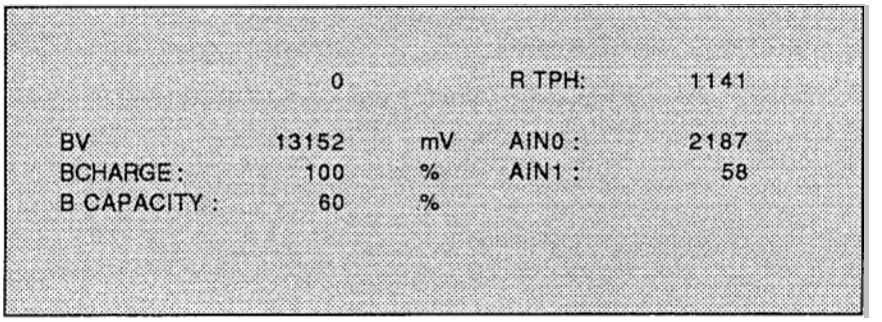
This counter gives the number of times re-synchronisation is necessary by skipping one ECG sample. On initial switch on this counter could read 5 to 10. Synchronisation is periodically required and over a 24 hour period the counter could be up to 100.

Offset Screen

This screen gives the value (and setting facility) for the thermal print head resistance and the value and setting option of various analog offsets for analog controlled stress test devices. A DVM is required to carry out the analog offset settings.

To enter the offset test screen proceed as follows:

Press <FNCT> <6> (electrode test) <ENTER> <ENTER>. The following display is shown:



This screen gives the following data and adjustments:

R TPH

The value indicated here is the resistance of the thermal print head and must be set to the correct resistance to ensure a good quality print-out. The print head resistance is found on the printer and can be accessed by removing the printer cover plate.

To set the resistance of the thermal print head press </>. The first figure of the resistance value is now highlighted and the new resistance value can be entered. The entered value must be more than 1000 Ohms and less than 1800 Ohms. If a resistance value outside of these limits is entered, the user is prompted to enter the value again. When the resistance is set press <ENTER>.

BV and AIN0

BV indicates the voltage level of +US (that is the battery voltage, or the primary dc voltage generated from the mains. The actual voltage level of +US is calculated from the BATTV signal (sheet 5 of the power supply circuit diagram) and shown on this screen as AIN0. The value of BV is between 13V and 15V (nom+13.5V) when working from the mains, and between +9V and 11V when using battery power (nom. 9.6V). The AIN0 indication (signal BATTV) is approximately 1700mV when working from the battery and 2200mV when working from the mains (via voltage divider giving a multiplication factor - to calculate BV- of about 6.128).

BCHARGE, AIN1 and B CAPACITY

AIN1 gives a voltage value indicating the loading control level of the battery (from the PSU - signal BATTLC). The voltage range is 0mV to 2000mV (0V indicates that the battery is fully charged, 2000mV indicates that the battery is fully discharged.

Offset Screen

Because every battery varies, the processor initially calculates the capacity of the battery so that it knows when to generate the battery low signal - the B CAPACITY indication gives the calculated capacity of the installed battery. When a new battery is installed, it must be fully charged and fully discharged a minimum of two times, so that the processor can accurately assess the capacity of the new battery.

The BCHARGE indication shows the remaining battery capacity and is calculated from BATTLC signal (AIN1 indication).

Note: The battery capacity displayed on the LCD information box is the actual remaining capacity of the battery and is calculated from B CAPACITY and AIN1. The remaining capacity displayed in the information box will not necessarily be the same as that shown for BCHARGE.

Software and Options

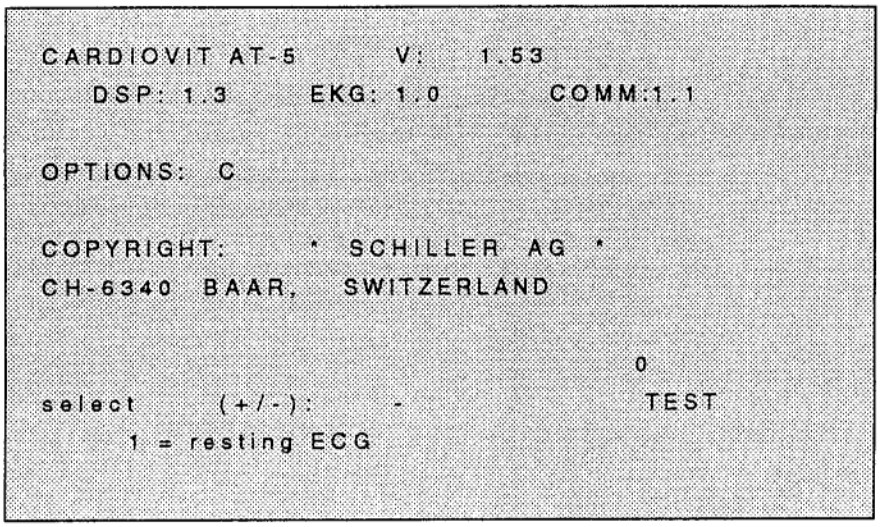
To check the software version of the unit and to display all the systems options that have been installed, proceed as follows:

Display the software option screen by pressing the key sequence:

<FNCT> <6> (Electrode Test) <.> (period)

Note: The actual key sequence may change slightly for different software versions.

The software version and the installed options are displayed on the LCD as follows:



- The top line gives the equipment name and the overall system software version of the unit; that is the software version of the EEPROMs in the Program Pack.
- The second and third line give the software version of all the software controlled peripherals in the AT-5. These are as follows:
  - EKG - the software version of the single chip processor on the ECG Amplifier Board
  - COMM - the software version of the communications controller on the Processor Board

Software and Options

- Below the software version details is the options line. This details the options that are installed. These are as follows:
  - C - Interpretation Program
  - S - Standard
  - M - Measurement
- The number below, and to the right of the Copyright notice, is a counter of the number of unauthorized attempts that have been made to incorporate extra options to the unit.

  Important - only 9 attempts are allowed and if this figure exceeds 9, no more upgrades are possible.
- The number immediately below the unauthorized attempts counter is the system serial number.
- The options on the bottom of the screen are the software updates that can be incorporated into the unit when the correct code is entered. To incorporate any of these software options the code must be entered, the option selected with the <+> and <-> keys and the <ENTER> key pressed. The code can be purchased from SCHILLER AG through your local dealer.

Chapter 6
Spare Parts

Contents

Introduction

This Chapter gives the part numbers for modules that can be replaced by the service engineer. The part numbers for disposables, accessories and dedicated test equipment are also included. When ordering state that the module required is for an AT-5 unit and provide the following:

- Part Title
- Part Number
- Software Version
- Serial number of the unit
- Your company address and a contact name

  Note: The software version and the serial number of the unit are found on the software screen (details in Chapter 5). The serial number is especially necessary when ordering mechanical parts to ensure that the correct version is identified by the processing department.

Additionally if you are returning a faulty module the following information, in as much detail as possible, will speed repair:

- the exact nature of the fault
- the circumstances, and function being carried out, when the fault occurred

IT IS RECOMMENDED THAT RETURNED MODULES ARE SENT BY REGISTERED POST.

IMPORTANT

ALL BOARDS AND STATIC SENSITIVE MODULES MUST BE RETURNED IN A SEALED STATIC SHIELDING BAG. NO RESPONSIBILITY CAN BE ACCEPTED FOR MODULES NOT SENT IN THIS WAY

The address to send your order is:

Schiller AG

Sales Department (Order Processing)

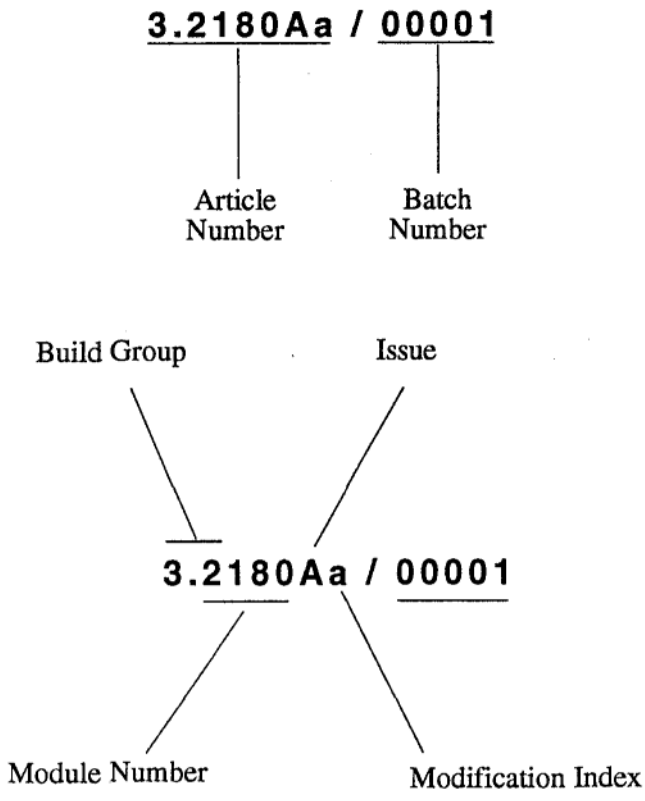
Altgasse 68

CH-6340 Baar

Switzerland

Module Identification

Every module has a unique part number. The number is either stencilled on the module or printed on an attached label. The module numbers are arranged as follows:



When ordering a module, only the article number has to be stated (without the modification index). The Batch number is a manufacturing identification number and need not be stated unless a module is suspected of having a manufacturing fault.

The article number is divided as follows:

Build Group Number	This number identifies the type of module or module group, for example electrical (PCB), mechanical, component etc.
Module Number	The individual module number
Issue Letter	This is always an upper case letter and gives the issue state of the module
Modification Index	This lower case letter gives the modification or build state of the module. It is applicable only for the specific Issue

The documentation associated with a module, is identified by a letter in place of the module build group number. For example the processor board for the AT-60 ECG unit without the Spirometry option, has the article number **3.2180Ga.**

The Circuit Diagram is **S.2180Ga,**

The Block Diagram is **B.2180Ga**

The Component Layout is **D.2180Ga.**

The categories are as follows:

DOCUMENT	IDENTIFICATION LETTER
CIRCUIT DIAGRAM	S
BLOCK DIAGRAM	B
COMPONENT LAYOUT	D
TEST DOCUMENTATION	P
ASSEMBLY DOCUMENTATION	F

Note that the Test Documentation and Assembly Documentation is usually available for internal use only.

AT-5 Spare Boards and Modules

DESCRIPTION	PART NUMBER
KEYBOARD MK-9-3C ENGLISH	3. 2323CA
KEYBOARD MK 9-3C GERMAN	3. 2322CA
KEYBOARD MK 9-3B FRENCH	3. 2324CA
KEYBOARD MK 9-3B ITALIAN	3. 2325BA
ECG BOARD MK 9-2B	3. 2321BJ
MICROPROCESSOR BOARD MK 9-1E	3. 2320EB
PROGRAM PACK MK 9-11	3. 2329BA
POWER SUPPLY BOARD MK 9-6F	3. 2327FH
INTERFACE BOARD MK 9-5D	3. 2326DF
PAPER TRAY DC MOTOR (COMPLETE)	3. 910 610
THERMAL PRINT HEAD	4. 140 114
THERMAL PRINTER MOTOR	3. 910 618
LCD 640 X 480	4. 600 064
NICKEL METAL HYDRID BATTERY PACK	4. 350 022

Cable Assemblies

DESCRIPTION	PART NUMBER
LCD CABLE ASSEMBLY	4. 520 321
FLYING LEAD TO LCD	4. 520 293
ECG CABLE ASSEMBLY (MK 9-2 TO MK 9-5)	4. 520 294
KEYBOARD CABLE ASSEMBLY (MK 9-3)	4. 520 324
POWER CABLE ASSEMBLY (MK 9-6 TO MK 9-5)	4. 520 299
MICROPROCESSOR CABLE ASSEMBLY (MK 9-1 TO MK 9-5)	4. 520 298
BEEPER CABLE	4. 520 328
DC MOTOR CABLE ASSEMBLY	4. 520 305
STEPPER MOTOR CABLE ASSEMBLY	4. 520 306
THERMAL PRINTER POWER CABLE ASSEMBLY	4. 520 331
PAPER MARK SENSOR CABLE ASSEMBLY	4. 520 309
GROUND (EARTHING) CABLE ASSEMBLY	4. 520 334
GROUND (EARTHING) CABLE ASSEMBLY	4. 520 335

Disposables

DESCRIPTION	PART NUMBER
THERMAL PRINTER PAPER	2. 157 013

Accessories

DESCRIPTION	PART NUMBER
GROUND CABLE	2. 310 005
POWER CABLE, USA (STRAIGHT)	2. 300 001
POWER CABLE, CH (ANGULAR)	2. 300 003
POWER CABLE, UK (ANGULAR)	2. 300 004
POWER CABLE, D (ANGULAR)	2. 300 005
ELECTRODE SET COMPRISING FOUR EXTREMITY STAINLESS STEEL ELECTRODES WITH RUBBER STRAPS, SIX PRECORDIAL SUCTION ELECTRODES AND ELECTRODE GEL	2. 000 041
PATIENT CABLE 2 M (BANANA PLUGS)	2. 400 006

Dedicated test equipment and special tools

The only special test equipment required for the AT-5 is the RS test plug (article number to be allocated).

Chapter 7
Technical Data

Contents

Technical Data

General

Dimensions (l/w/h):	260 x 205 x 60 mm
Weight:	approx. 2.7 kg
Power supply requirements:	100 to 240Vac, 50 / 60Hz
Power consumption:	25W
Battery:	9.6 V Nickel Metal Hydrid Battery Pack giving one hour of continuous use (without using printer)
Printing process:	high-resolution thermal printhead, 8 dots per mm (amplitude axis), 40 dots per mm (time axis) @ 25mm/s
Paper speed:	2.5 / 5 / 10 / 12.5 / 25 / 50 / 100 mm/s
Sensitivities:	2.5 / 5 / 10 / 20mm/mV
Recording tracks:	3, 4 or 6 channels, automatic baseline adjustment
Chart paper:	thermoreactive, Z-folded, perforation for A5 format
Liquid crystal display:	Backlighted liquid crystal display for ECG monitoring and alphanumeric information
	Resolution: 480 x 640 dots; viewing angle adjustable
Frequency range of the digital recorder:	0 Hz - 150 Hz (IEC); 0 Hz - 150 Hz (AHA)
Test socket for patient cable:	for testing of electrode cables for interruptions and short-circuit; control light indication
Patient input:	fully floating and isolated, defibrillation protected
Patient leakage current:	less than 5 µA
Safety standard:	CF according to IEC
Protection class:	I according to IEC
Environmental conditions:	temperature, operating: 10° to 40 °C
	temperature, storage: 0° to 50°C
	relative humidity: 25 to 95 % (non-condensing)
Keyboard:	splashproof keys

Technical Data

Data record:	Listing of ECG recording data, date and time of recording, patient data, etc.
	Version M & C: ECG measurement results (intervals, amplitudes, electrical axes), average complexes with optional measurement reference markings
	Version C: ECG interpretation statements
Long-term rhythm recordings:	1 lead, 60 sec / page
	1 lead, 3 min / page
	1 lead, 6 min / page
	1 lead, 20 min / page
ECG storage:	Output memory for 10s (12 ECG leads)
Myogram filter (muscle tremor filter):	adjustable at 25 or 35 Hz, only effective for printed ECG
Line frequency filter:	distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of adaptive digital filtering

Experimental Input Connectors DC1, DC2

Jack plug positive and negative maximum input voltage 2.5V p-p.

RS-232 Serial Interface

Protocol:	Asynchronous
Baud Rate:	75 to 153600 Baud
Byte Format:	1 start bit, 8 data bits.
	0 or 1 parity bit (+ or -), programmable
	1 / 1.5 / 2 stop bits, programmable.
Transfer Control:	by means of DTR, DSR, CTS, RTS
Connection Socket:	D subminiature (9 pole female), wired as DTE (Data Terminal Equipment).
Pin Connections:	Pin 3 TXD1 0 (output data)
	Pin 2 RXD1 I (input data)
	Pin 7 RTS1 0 (request for output)
	Pin 8 CTS1 I (ready for output)
	Pin 6 DSR1 I (transfer unit ready)
	Pin 4 DTR1 0 (ready)
	Pin 5 GND

Chapter 8
Glossary

Contents

Introduction

The following list provides a glossary of all signal and general acronyms used in this book and in the AT-5 circuits.

Where signal names are obvious or repetitive they are not repeated - for example every chip select signal is preceded by CS followed by the peripheral selected (e.g. CSDAC is the chip select for the digital / analog converter). When this occurs the common term (CS) is given, but not all the obvious derivatives. When a common term is given, two periods ` .. ´ indicate that other characters can follow or precede it.

Only abbreviations that are specific to the AT-5 are included here. General electrical and electronic abbreviations are not included.

Signals and Acronyms used in the AT-5

• ..OS	Offset signal (on the ECG Amplifier)
• A(1..23)	CPU Address Bus
• ALBEEP	Alarm Beeper Signal to the Audio Amplifier. The frequency of this signal is about 1000Hz
• ANA1, ANA2	Analog Input from the experimental inputs DC1 and DC2
• AS	Address Strobe
• BATTLC	Analog signal to the processor giving the charge condition of the battery
• BATTV	Battery voltage - analog signal from the Power Supply used by the processor to assess battery or mains operation. Also used to generate software switch-off when voltage below approximately 8.9V
• CHAD..	ECG signal multiplexer control (from the processor)
• CI(0..10)	RS Interface Control Lines - Input
• CIF(0..16)	Communication Interface. General control signals for the communications interface circuits
• CL1	19kHz LCD latch pulse
• CL2	3.11MHz LCD clock frequency
• CLK..	Clock Signal. The number following the CLK indicates the frequency. For example CLK19 indicates a frequency of 19MHz
• CO(0..10)	RS Interface Control Lines - Output
• CS ..	Chip Select. The general format of the chip select signals is CS followed by some characters. The characters indicate the device to which the chip select signal appertains. For example CSRTC is the chip select signal for the real time clock and CSEPROM is the select signal for the EPROM.
• CTS	Clear To Send. General signal used in data communication
• D (0..15)	Data Bus
• DACWR	Digital / Analog Converter Write
• DMUX	Data multiplexer
• DRAM	Dynamic RAM
• DRC(0..6)	Dynamic RAM Control
• DS ..	Data Strobe
• DSP ..	Digital Signal Processor
• DTACK	Transfer Data Acknowledge. Bus signal to acknowledge transfer of data

Signals and Acronyms used in the AT-5

- UCAS — Upper Column address Strobe (for dynamic RAM)
- UD1, UD2 — Upper Data Strobe - used for generating UOE and UWE
- UOE — Upper Output Enable
- +UB — Battery Voltage
- +UP — Voltage rectified from the mains input and regulated to approximately +15V
- +US — Switched Input voltage (switched via ON/OFF control) used by all PSUs on the Power Supply Board and from the rectified mains (+UP) or from the battery (+UB).
- UWE — Upper Write Enable
- VCC — +5V
- VMA — Valid memory Address (not used)
- VPA — Valid peripheral Address
- VSYNC — Vertical Synchronisation - (video/VGA output)
- ZEROSET — Baseline reset (on the ECG Amplifier) from the Processor

ANNEX A

CIRCUIT DIAGRAMS AND COMPONENT LAYOUTS

Contents

ANNEX B

TYPICAL WAVEFORMS

This Annex gives print-outs of all the major input/output waveforms of each board and provides details of where and how they have been taken. The aim of this Annex is to provide sample measurements to assist the service engineer in quickly isolating a fault to a particular board. The content of this annex is currently being assessed and will be issued at a later date.

Service Handbook Document History AT-5

Service Handbook Issue 2 July 1998 Art. No. 2.540 007 Delivery date: 03.07.98

							Receipt Acknowledged						
Unit	**Detail**	**Article Number**	**Drawing date**	**Description**	**HW**	**Delivery date**	**DE**	**AU**	**IT**	**FR**	**US**	**CHD**	**CHB**
AT-5	AT5PRG	REV-Aa	13.04.93	Programmer-Adapter		03.07.98							
AT-5	AT5VERB	REV-Ba	27.03.93	Verbindungs-Konzept									
		REV-CA	01.10.93			03.07.98							
AT-5	MK9-1	2320Aa	29.03.93	Processor Board									
		2320Ba	04.10.93										
		2320Bc	15.02.94										
		2320Ca	15.02.94										
		2320Da	29.03.94										
		2320Ea	08.06.94										
		2320Eb	05.02.96			03.07.98							
AT-5	MK9-11	2329Aa	21.03.93	Program Pack		03.07.98							
AT-5	MK9-2	2321Aa	18.05.93	ECG-Interface									
		2321Ba	12.10.93										
		2321Bb	26.11.93										
		2321Bc	20.12.93										
		2321Bd	21.12.93										
		2321Be	25.01.94										
		2321Bf	04.07.94										
		2321Bg	19.04.95										
		2321Bh	19.04.95										
		2321Bi		Kein Schema									
		2321BJ	24.02.98			03.07.98							
AT-5	MK9-3	2322Aa	04.04.93	Keyboard									
		2322Ba	15.06.93										
		2322Ca	07.03.94			03.07.98							

AT-5	MK9-5	2326Aa	06.05.93	Printer-Interface									
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		2326Dd	18.03.96										
		2326De	08.08.96										
		2326DF	27.01.97			03.07.98							
AT-5	MK9-6	2327Ca	14.07.93	Power Supply									
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		2327EA	30.09.96										
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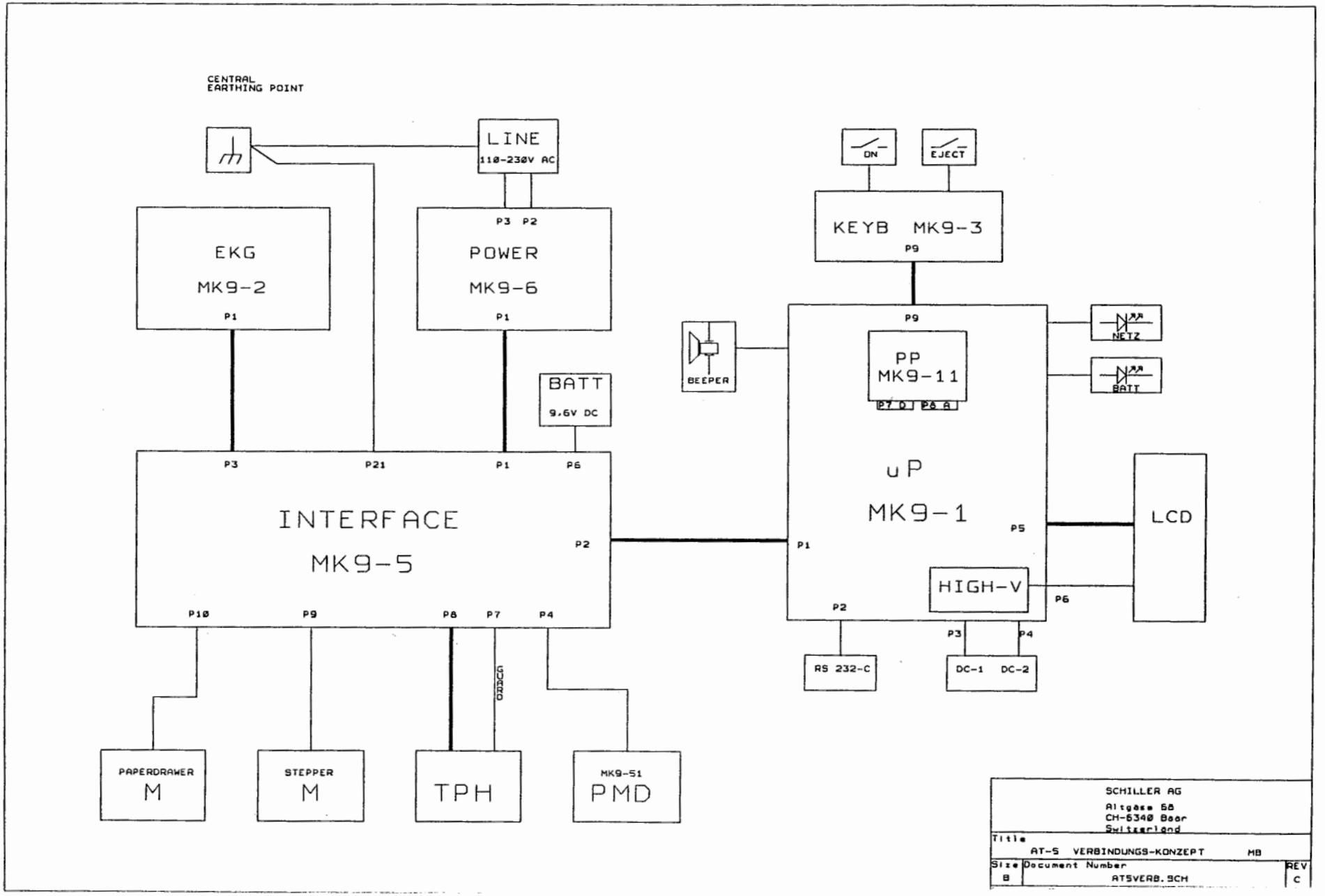
1/2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EARTHING POINT
LINE
110-230V AC
P3 P2
EKG
MK9-2
P1
POWER
MK9-6
P1
BATT
9.6V DC
P3
P21
P1
P6
INTERFACE
MK9-5
P2
P10
P9
P8
P7
P4
PAPERDRAWER
M
STEPPER
M
TPH
MK9-51
PMD
ON
EJECT
KEYB MK9-3
P9
P9
BEEPER
PP
MK9-11
P7 D
P8 A
NETZ
BATT
uP
MK9-1
P1
P5
LCD
HIGH-V
P6
P2
P3
P4
RS 232-C
DC-1
DC-2
SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland
Title
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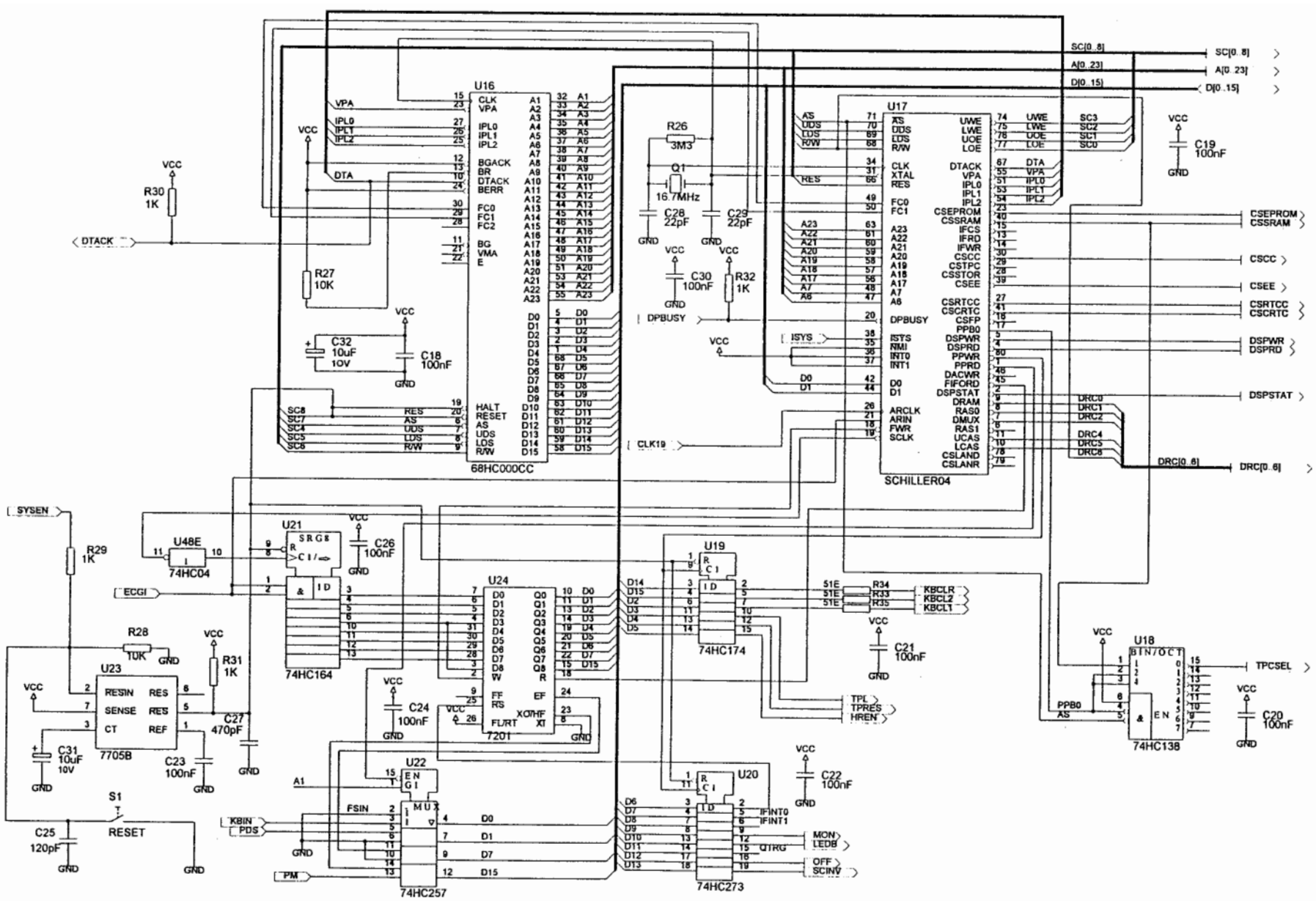
Size
B
Document Number
ATSVERB.SCH
REV
C



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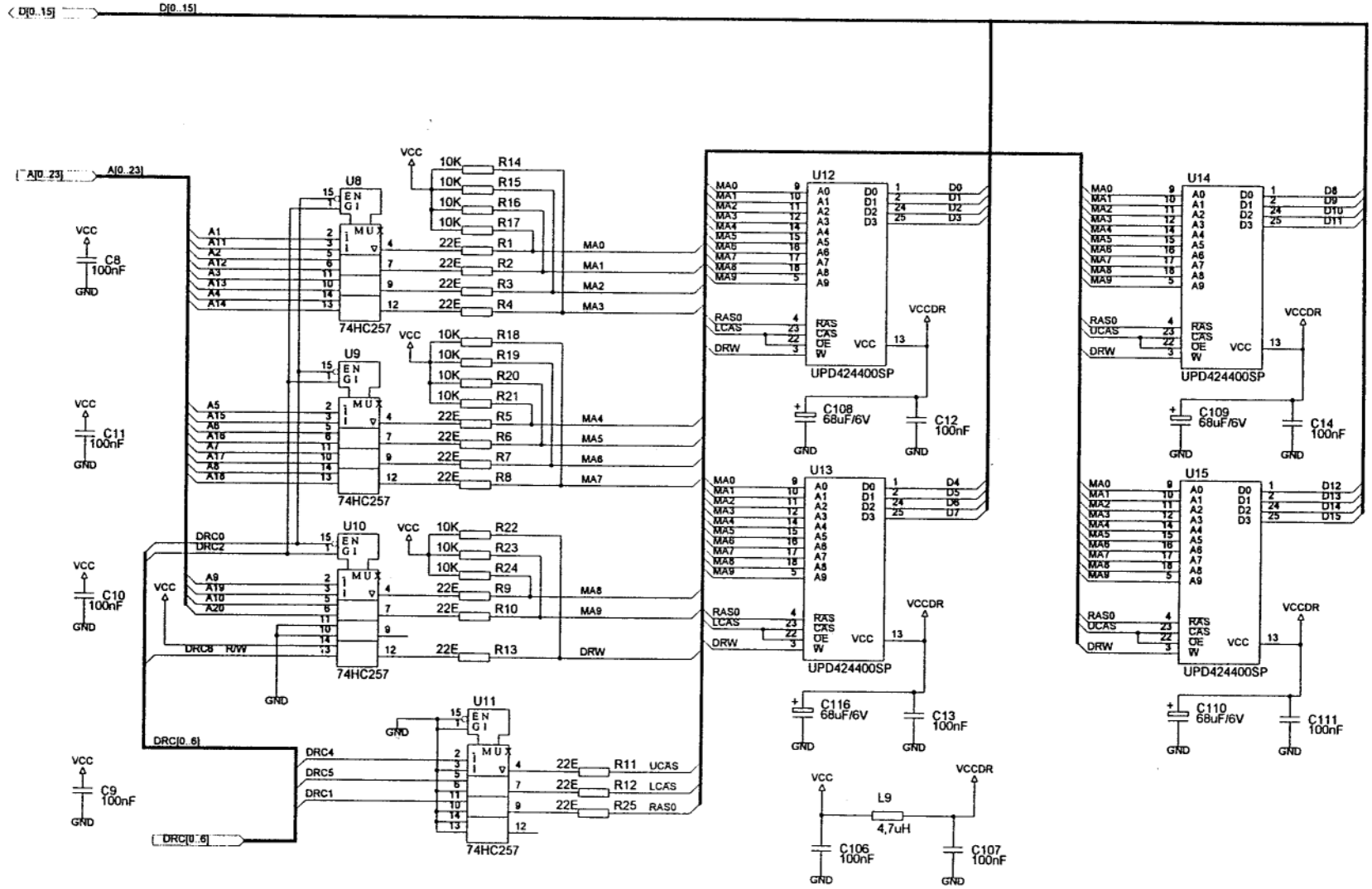

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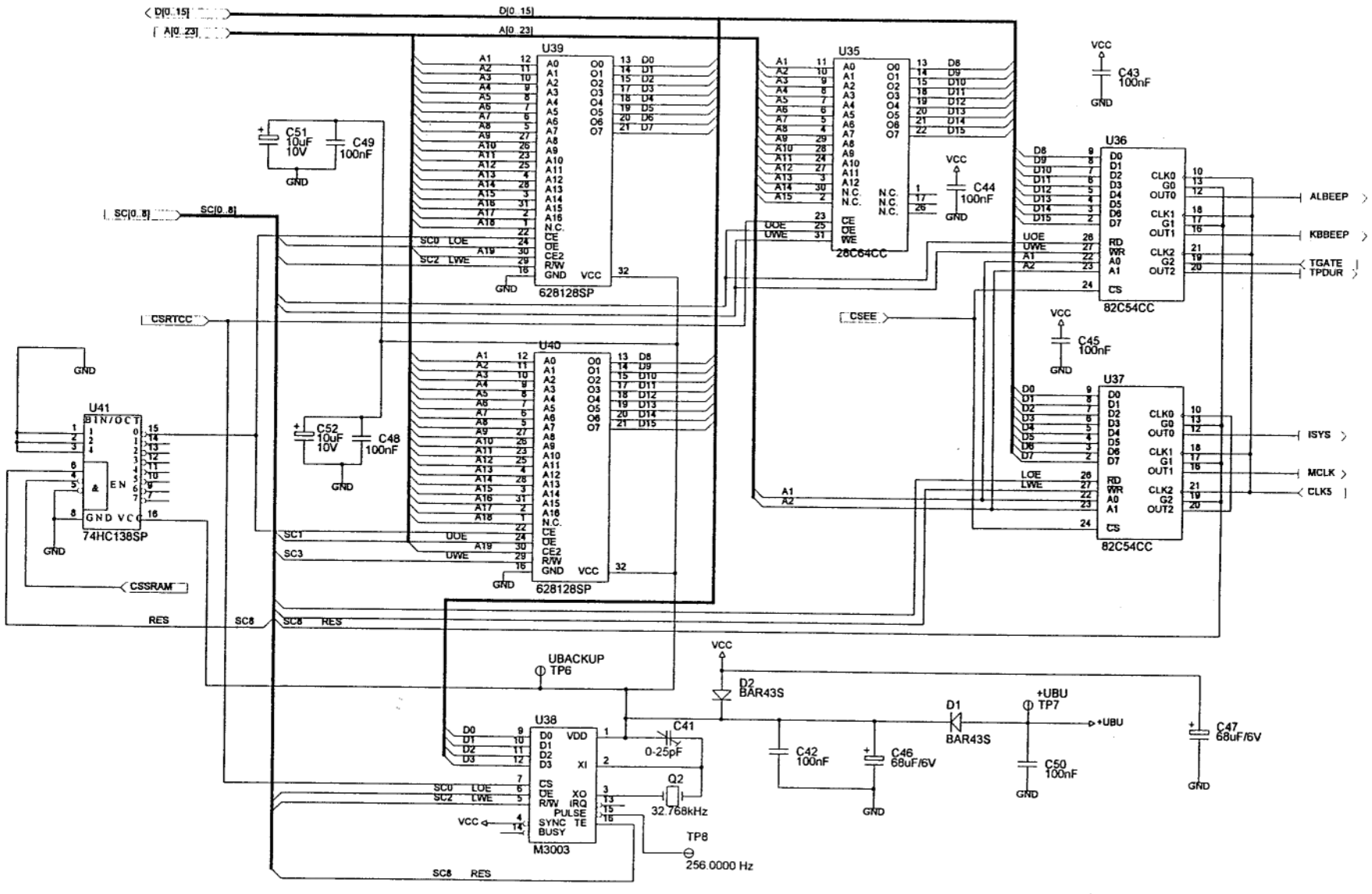

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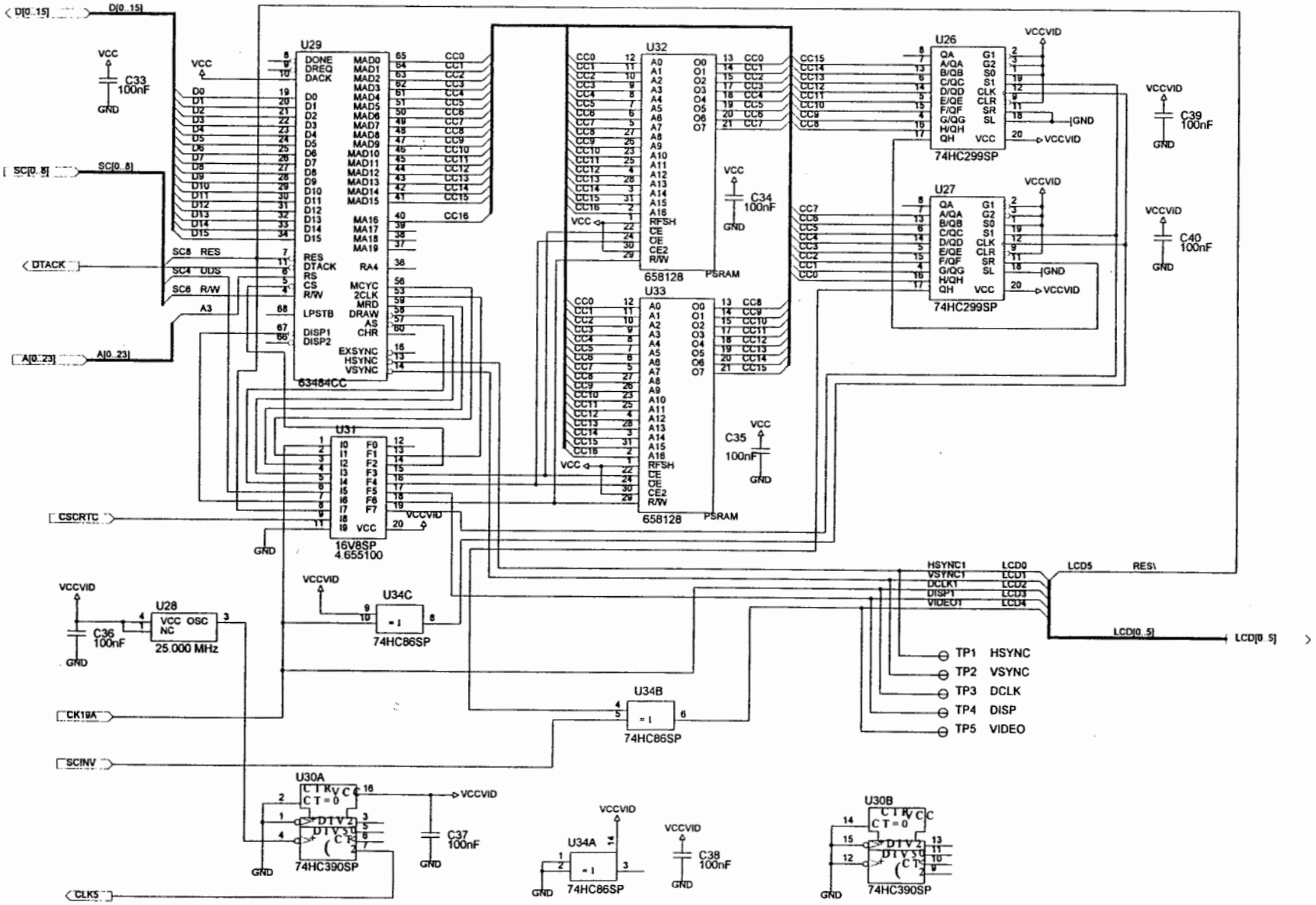

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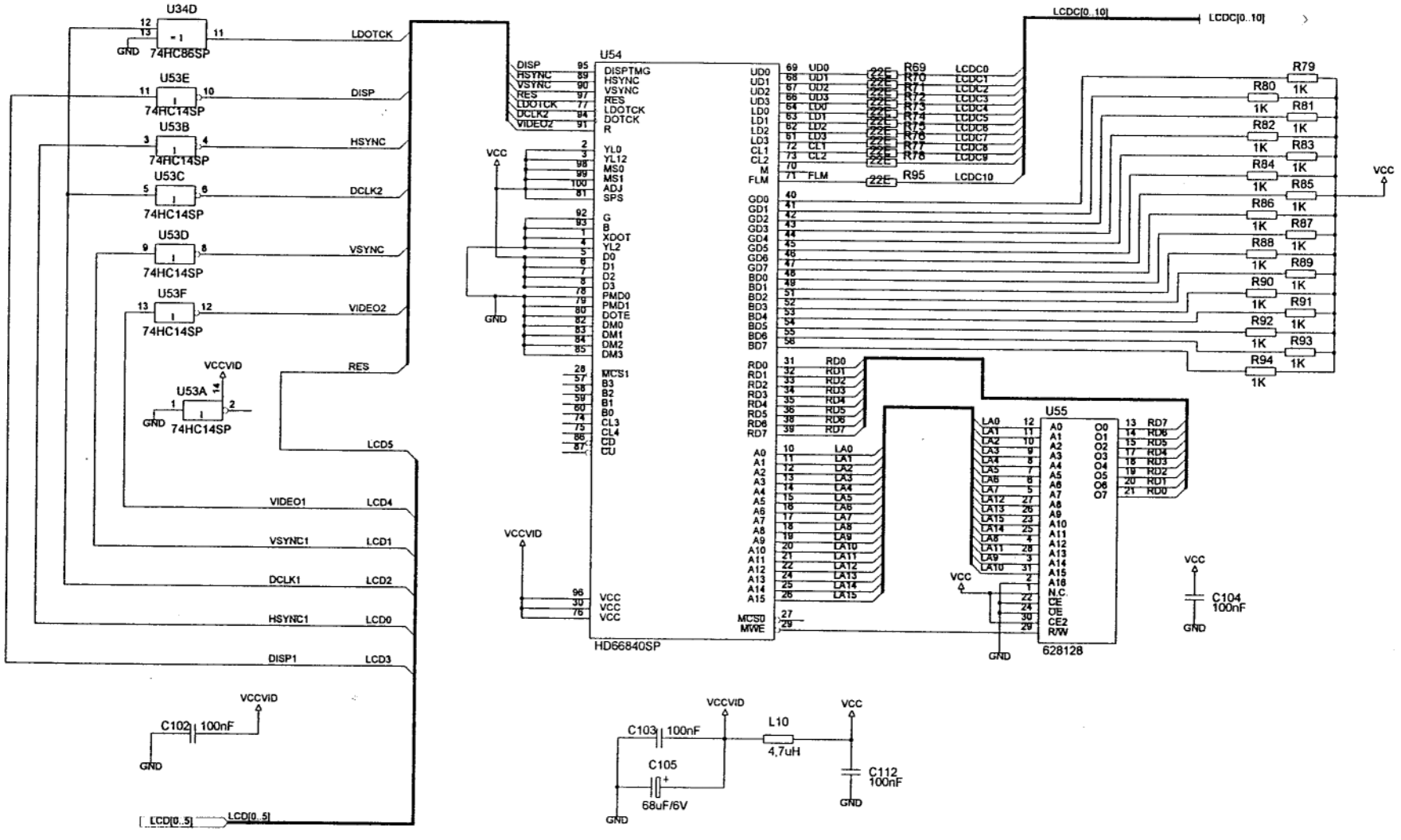

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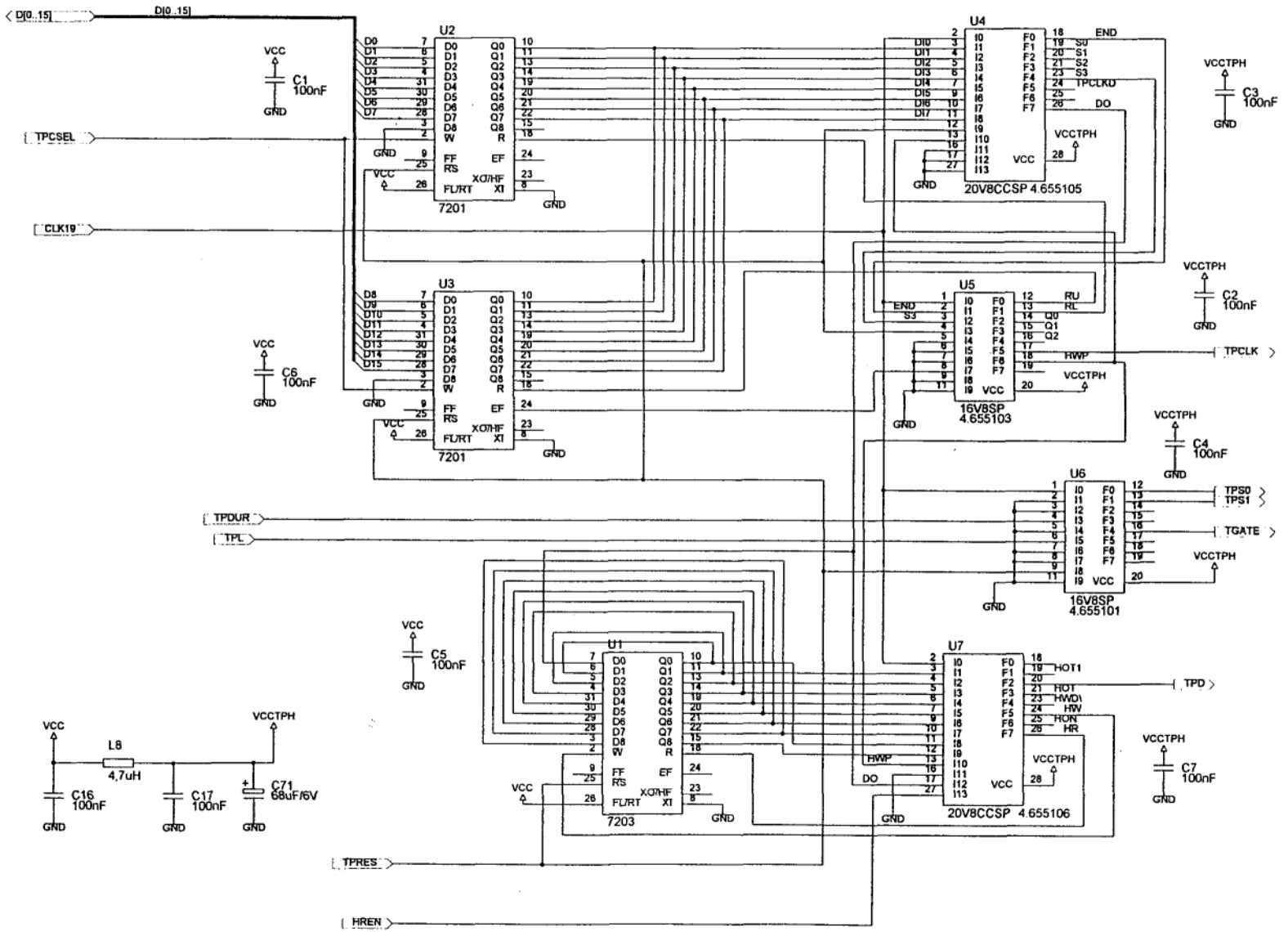

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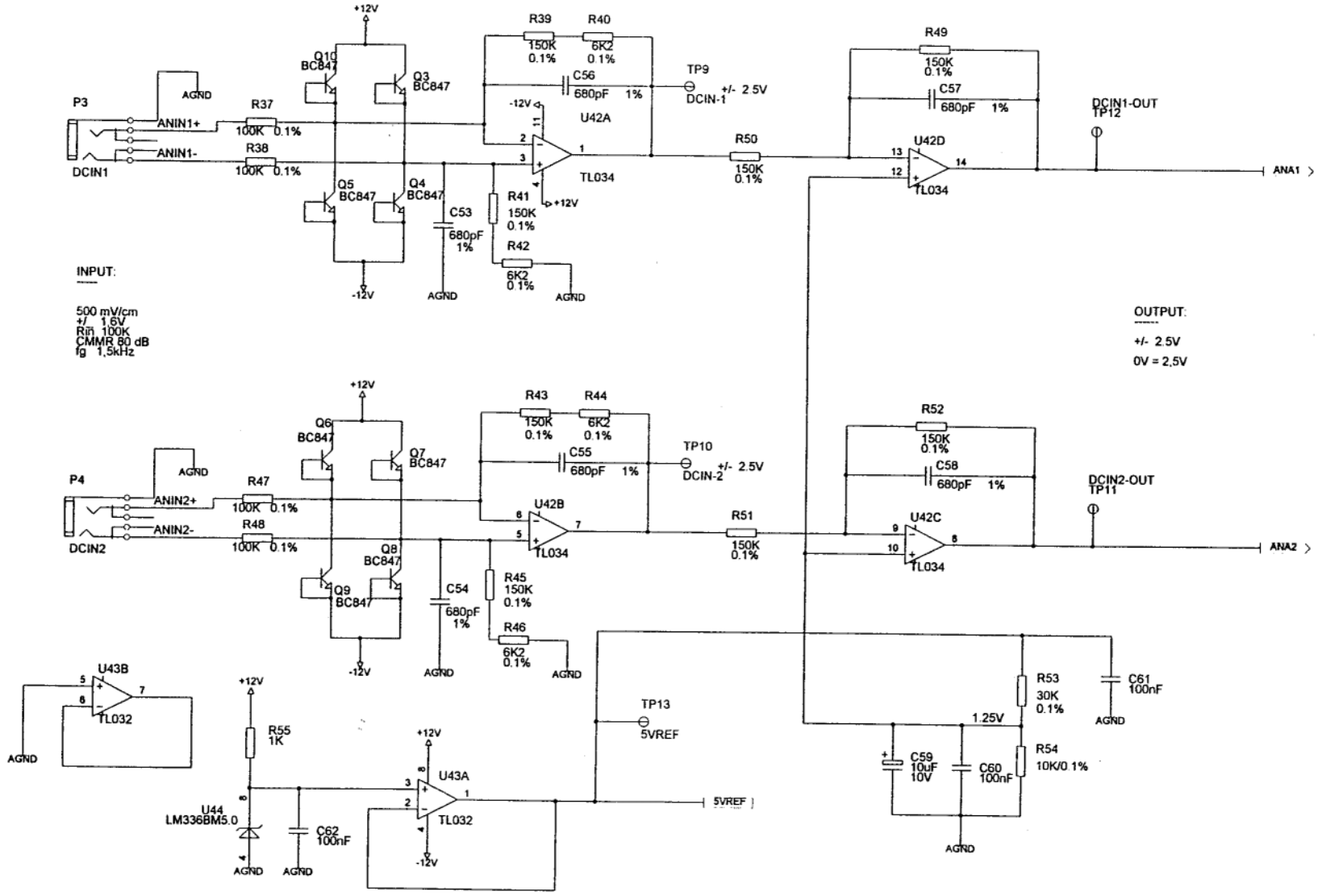

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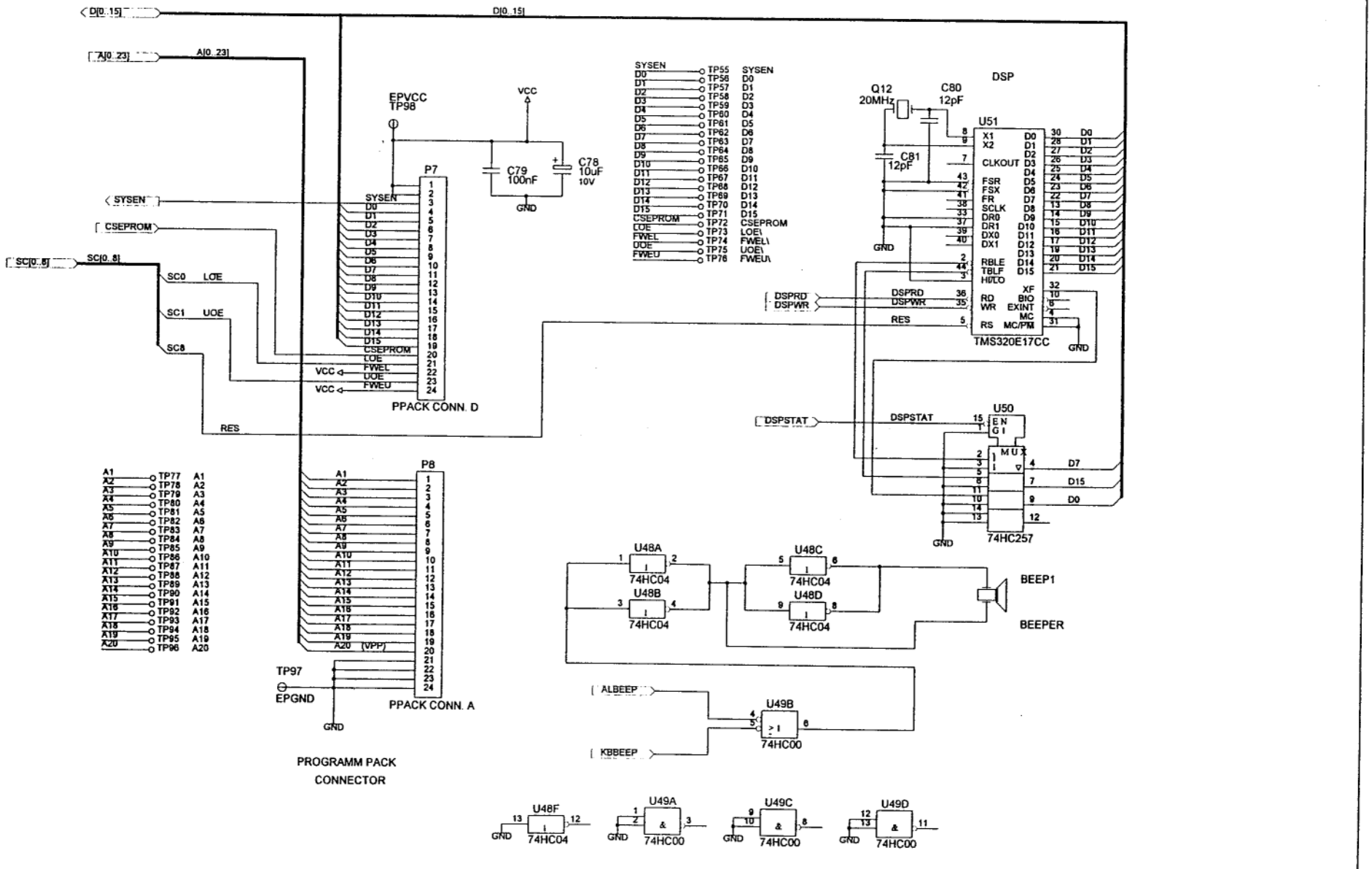

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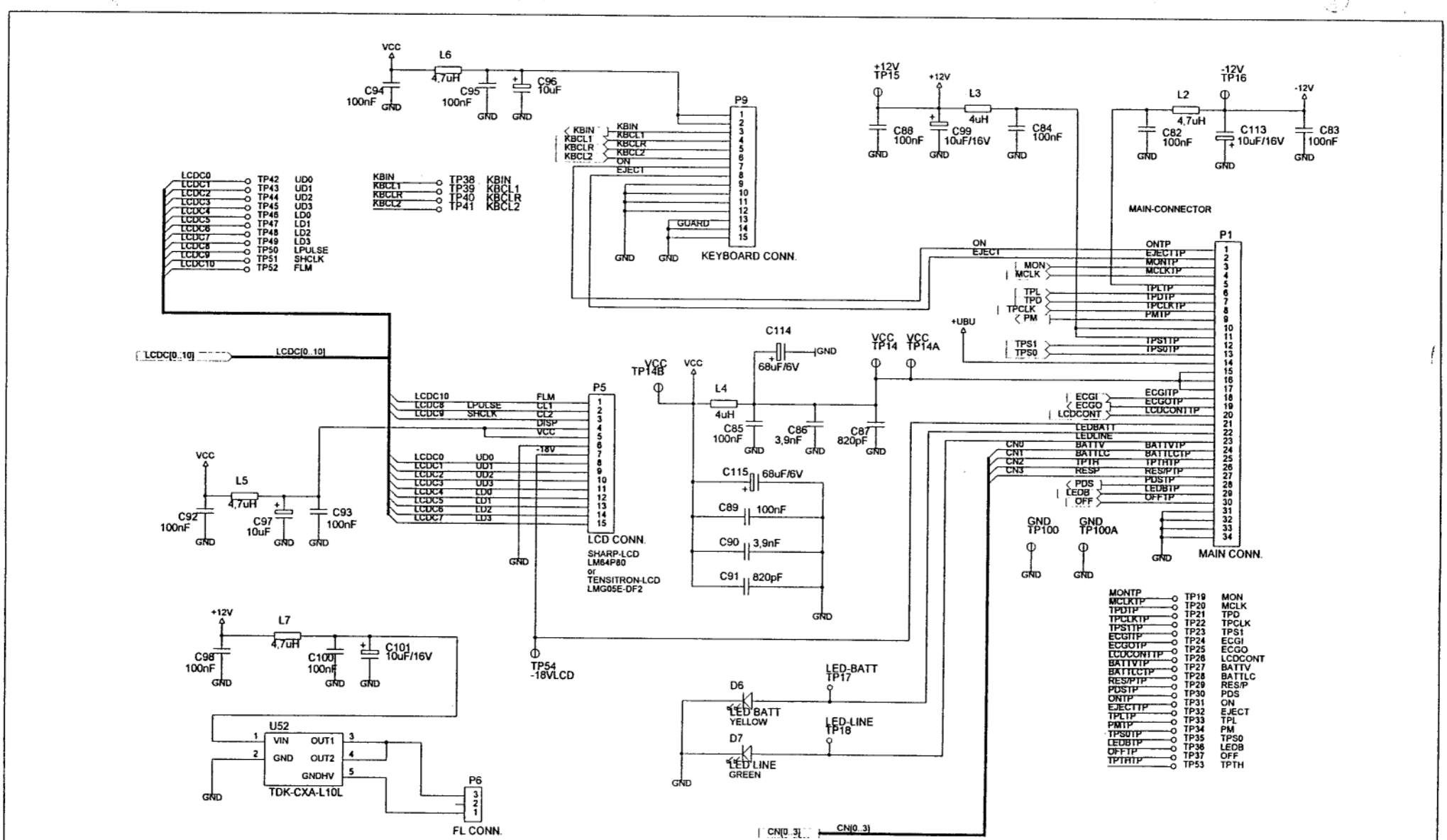

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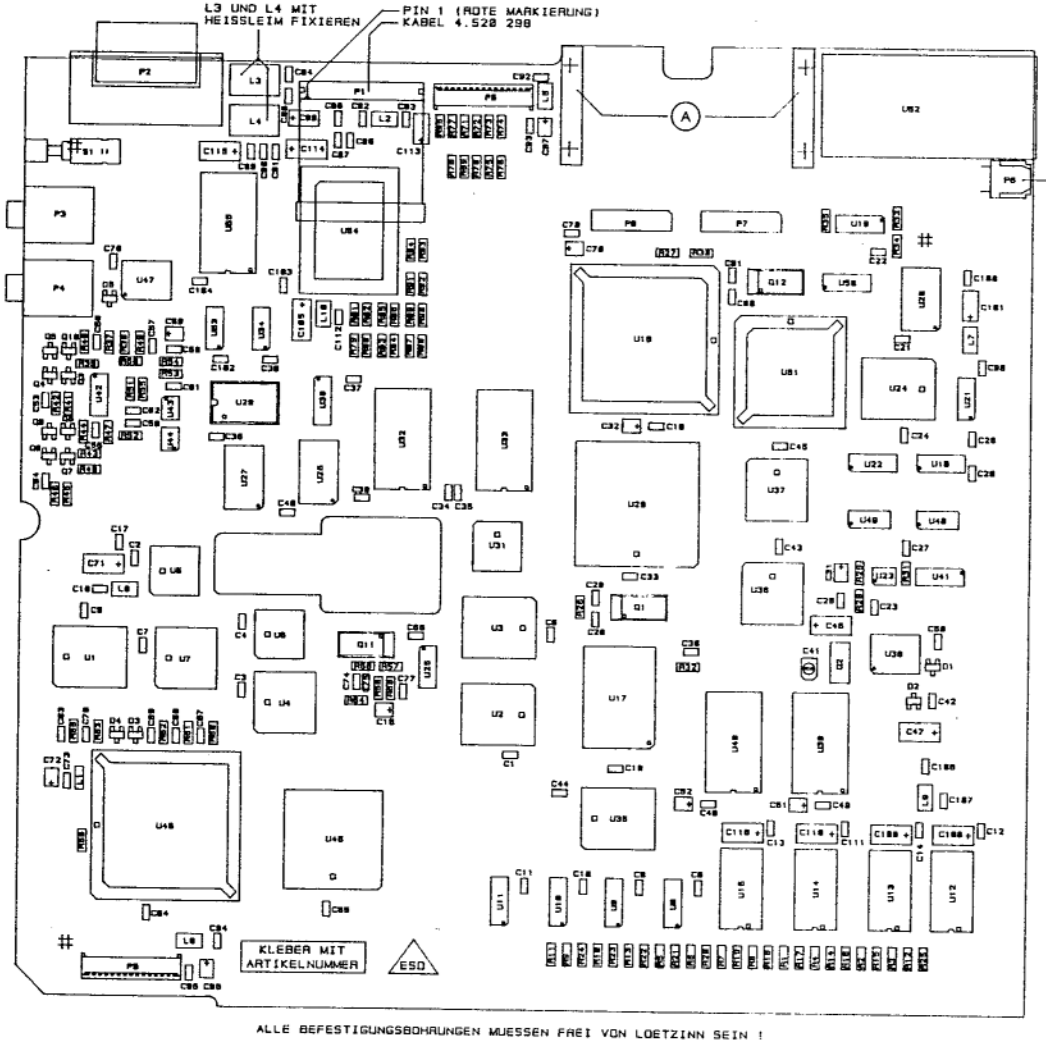
Drawn by: L.Strasser		Date: 5-Feb-1996 Sheet11 of 11	CH-6340 Baar
			Switzerland



ALLE BEFESTIGUNGSBOHRUNGEN MUESSEN FREI VON LOETZINN SEIN !

ALLE PINS AUF LOETSEITE AUF 0.5 MM
KUERZEN (EMV-KURZSCHLUSSGEFAHR)

(A) FUEHRUNGSSCHIENEN
ZU PROGRAMM PACK
4.435 164 (2 STUECK)
BEFESTIGUNG M2X6 (4STUECK)

SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland

Visum
Gez : SIR.
Entw :
Prod :

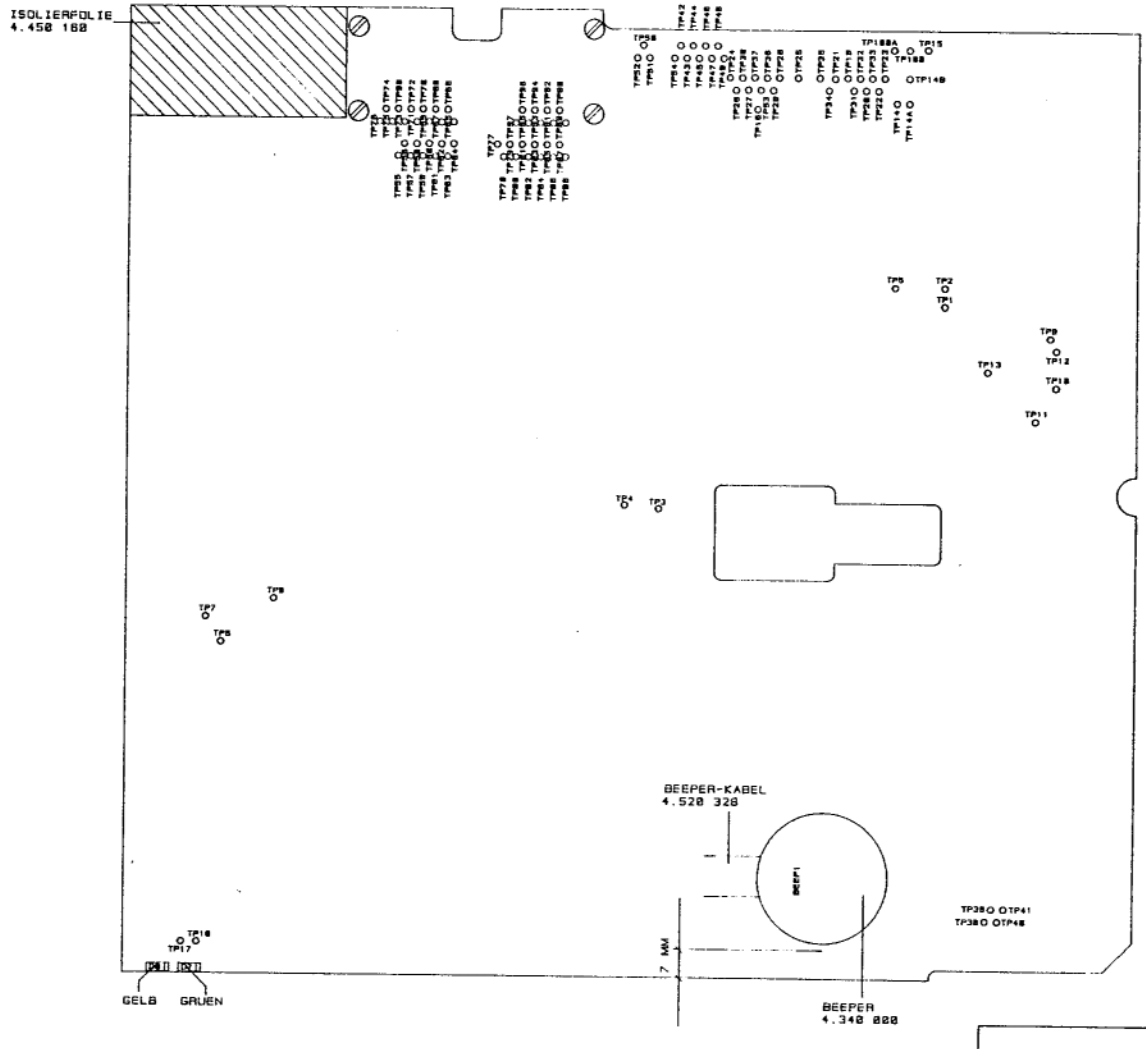
Title
PROCESSOR BOARD MK9-1

BAUTEILESEITE
A1 5

Size | Document Number
D.2320EA

Date: 23.10.1996

Sheet 1 of



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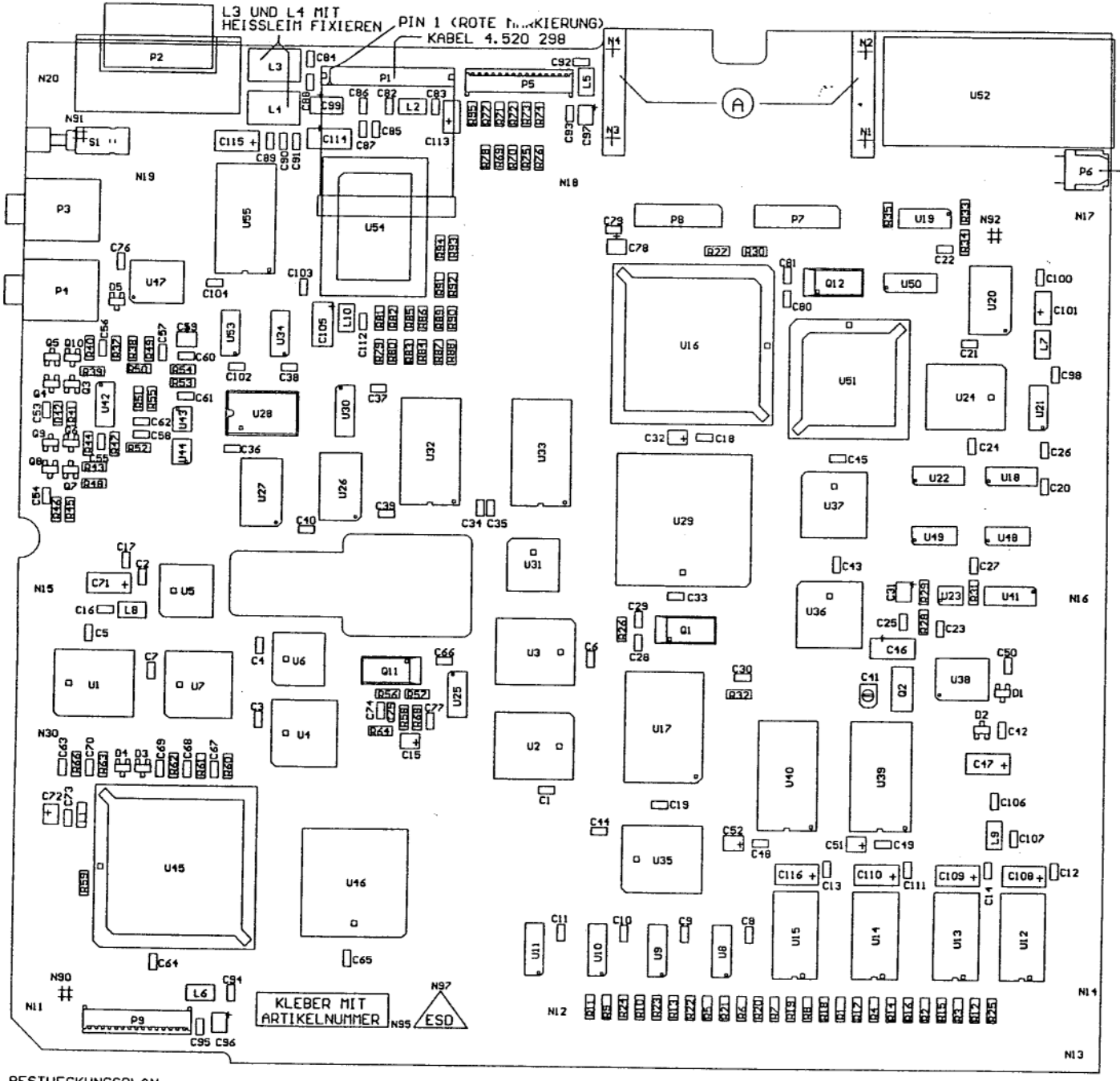

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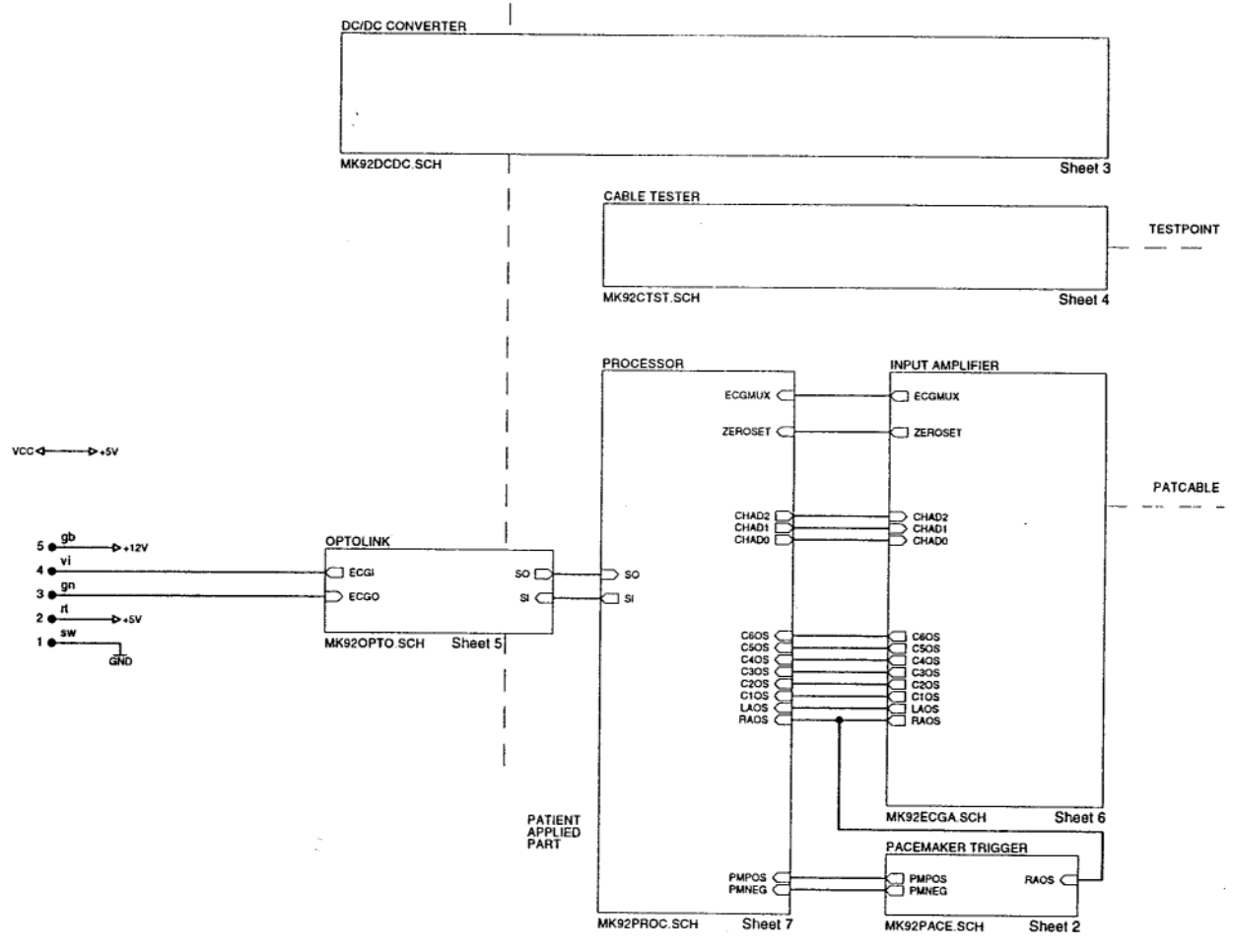
(A) FUEHRUNGSSCHIENEN
ZU PROGRAMM PACK
4.435 164 (2 STUECK)
BEFESTIGUNG M2X6 (4STUECK)

SCHILLER AG SWITZERLAND
Bezeichnung : MK9-1 (AT-5)
Version : E
Datum : 23.10.1996

D. 2320EA

BESTUECKUNGSPLAN

ALLE BEFESTIGUNGSBOHRUNGEN MUESSEN FREI VON LOETZINN SEIN !



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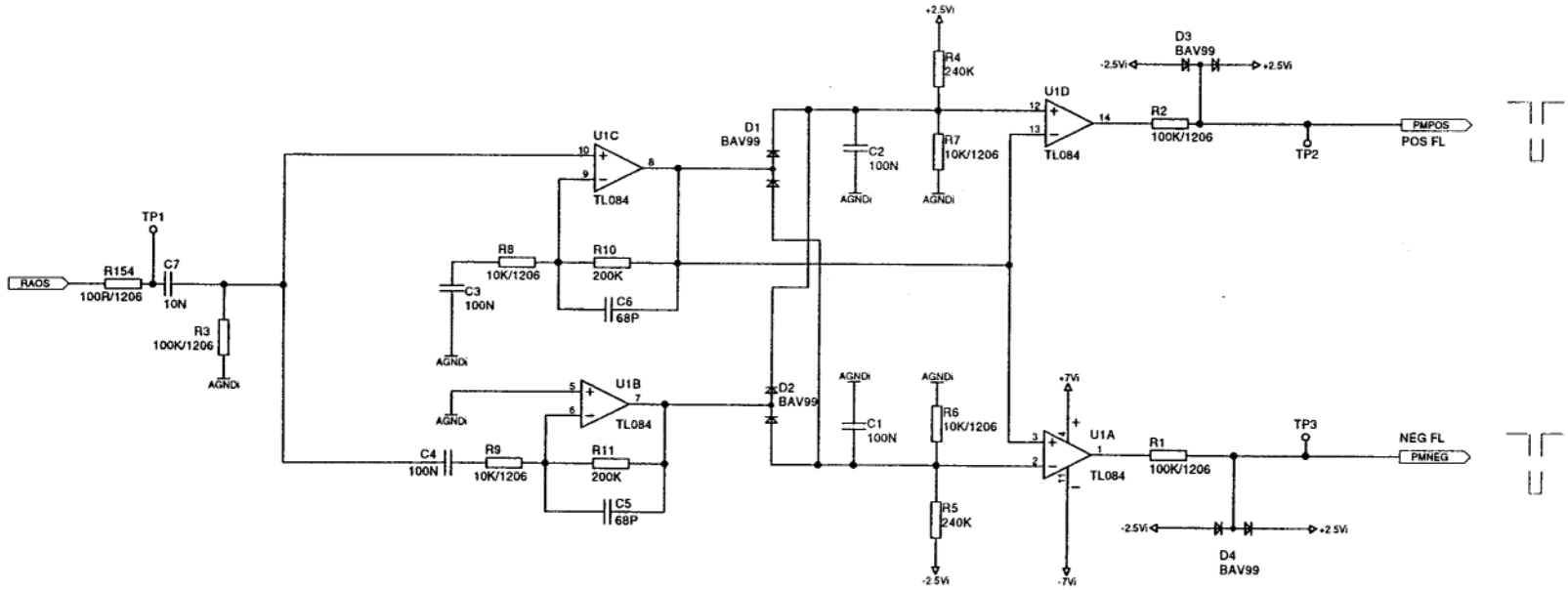

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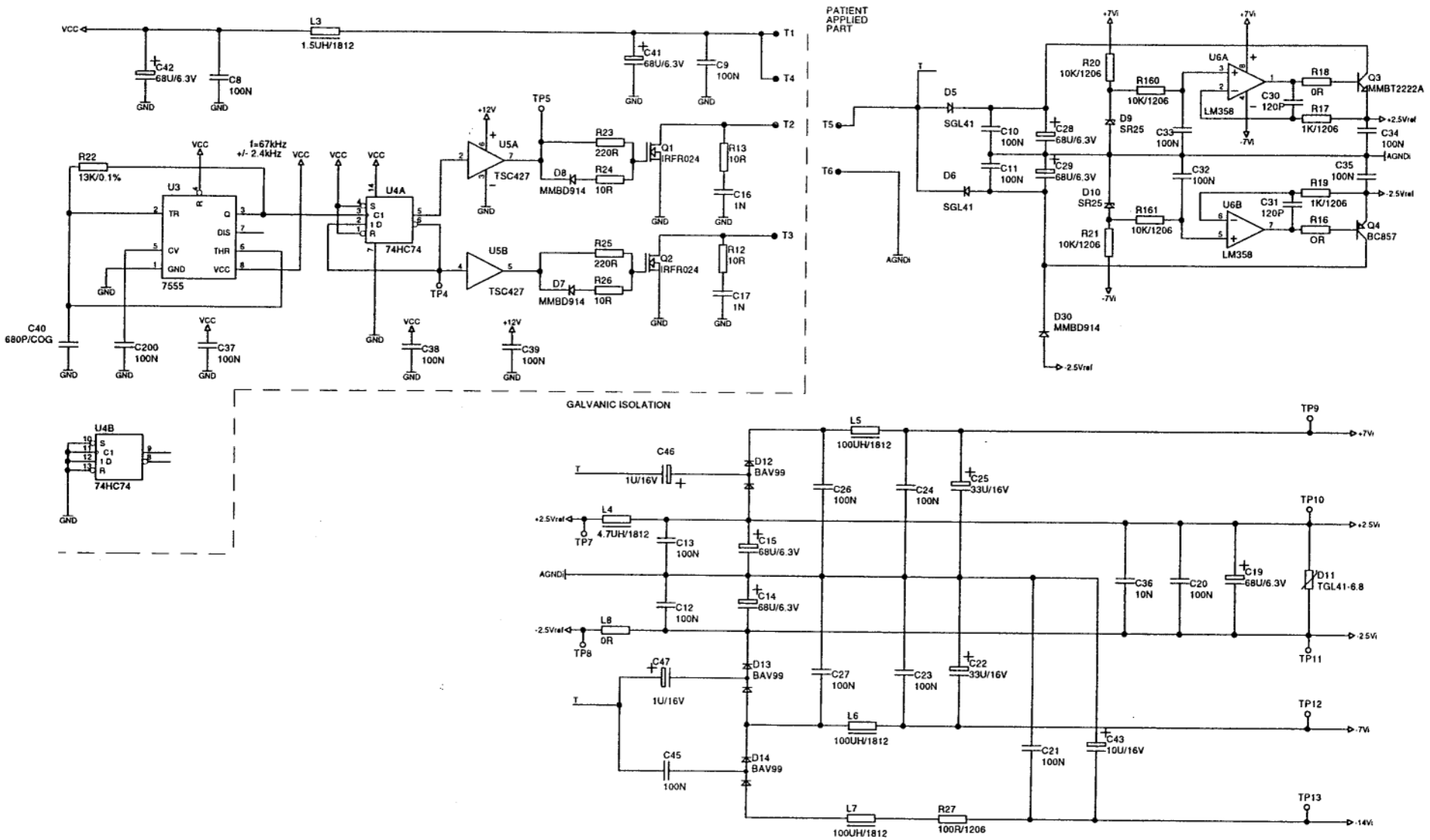

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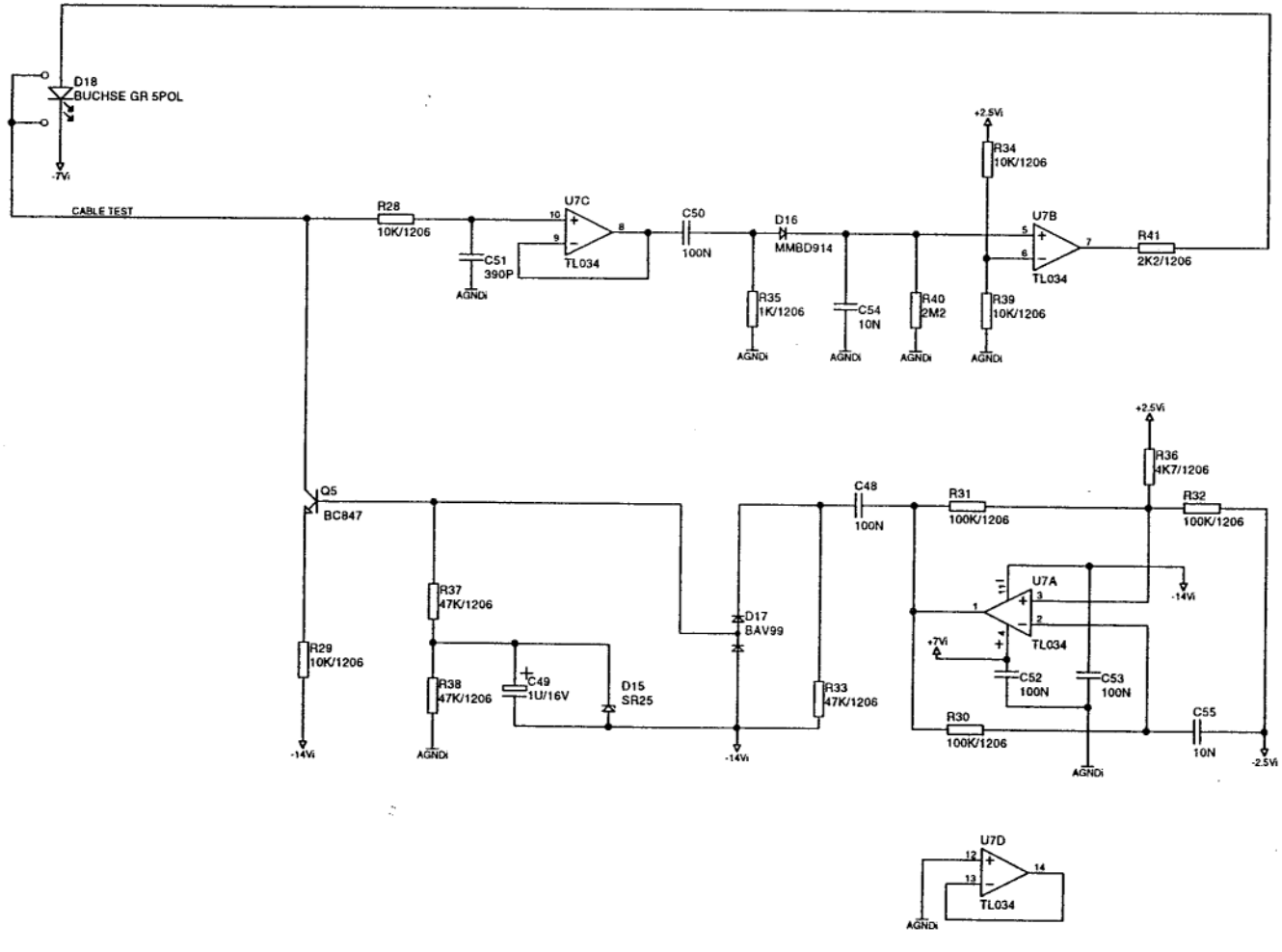

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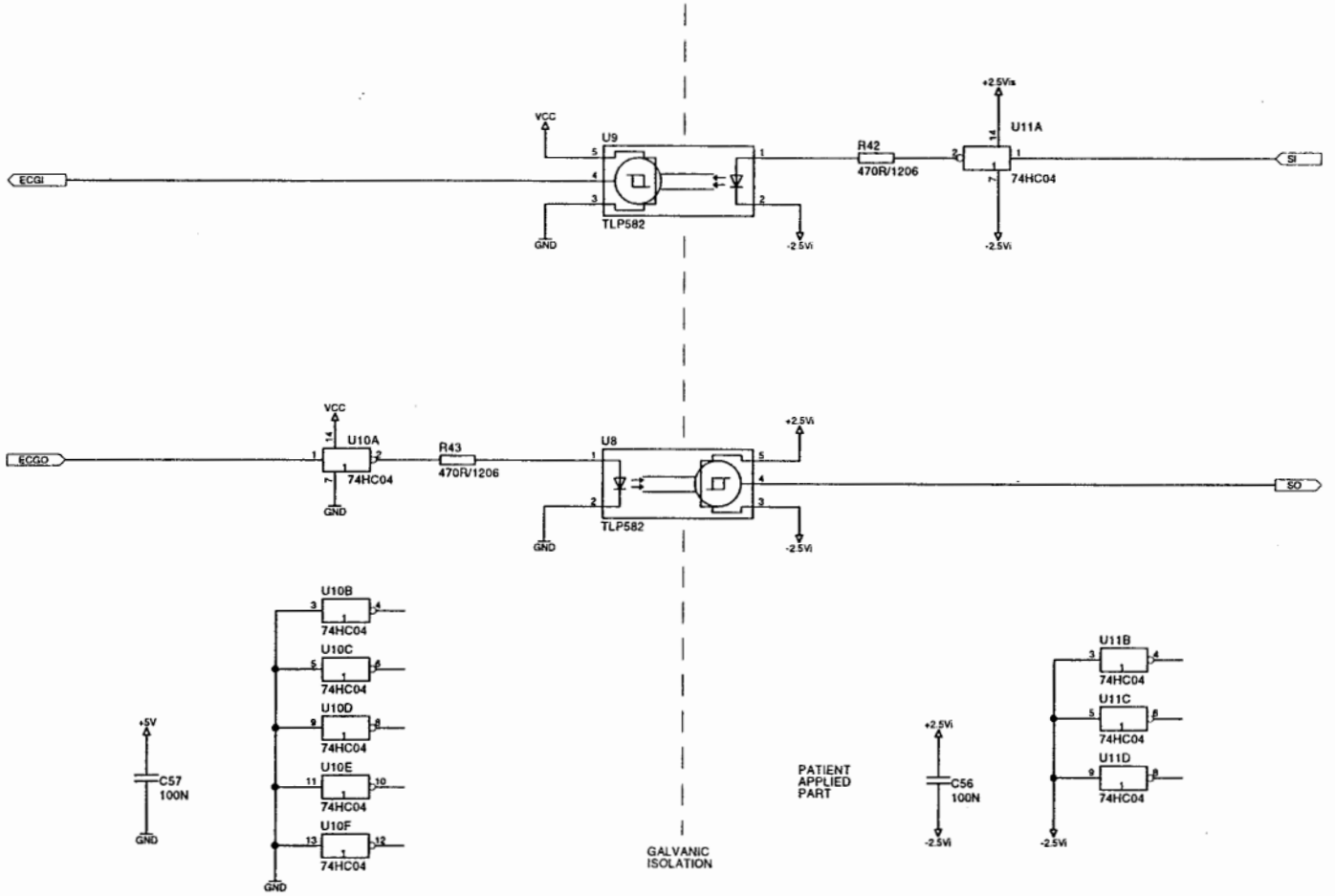

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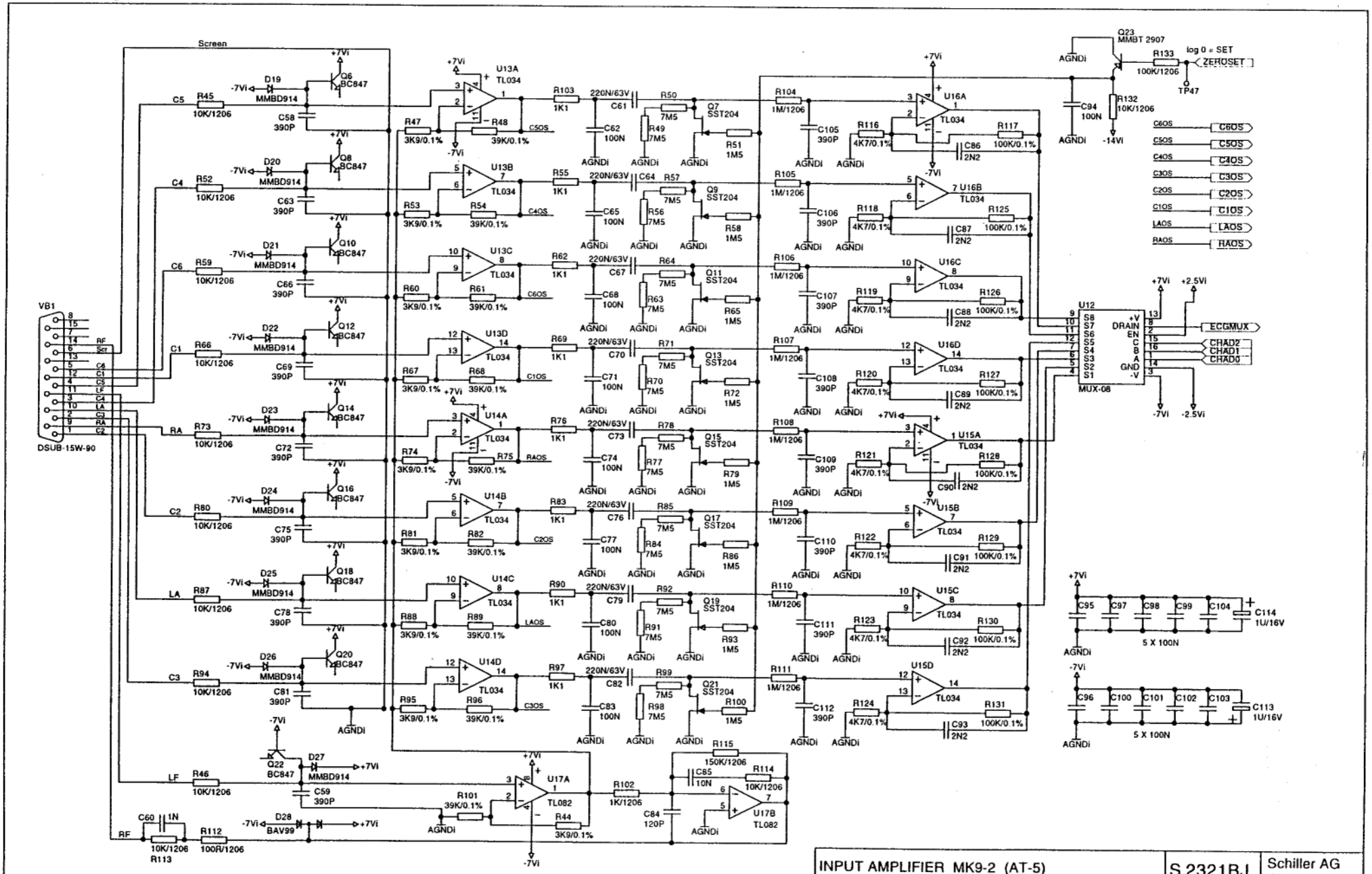
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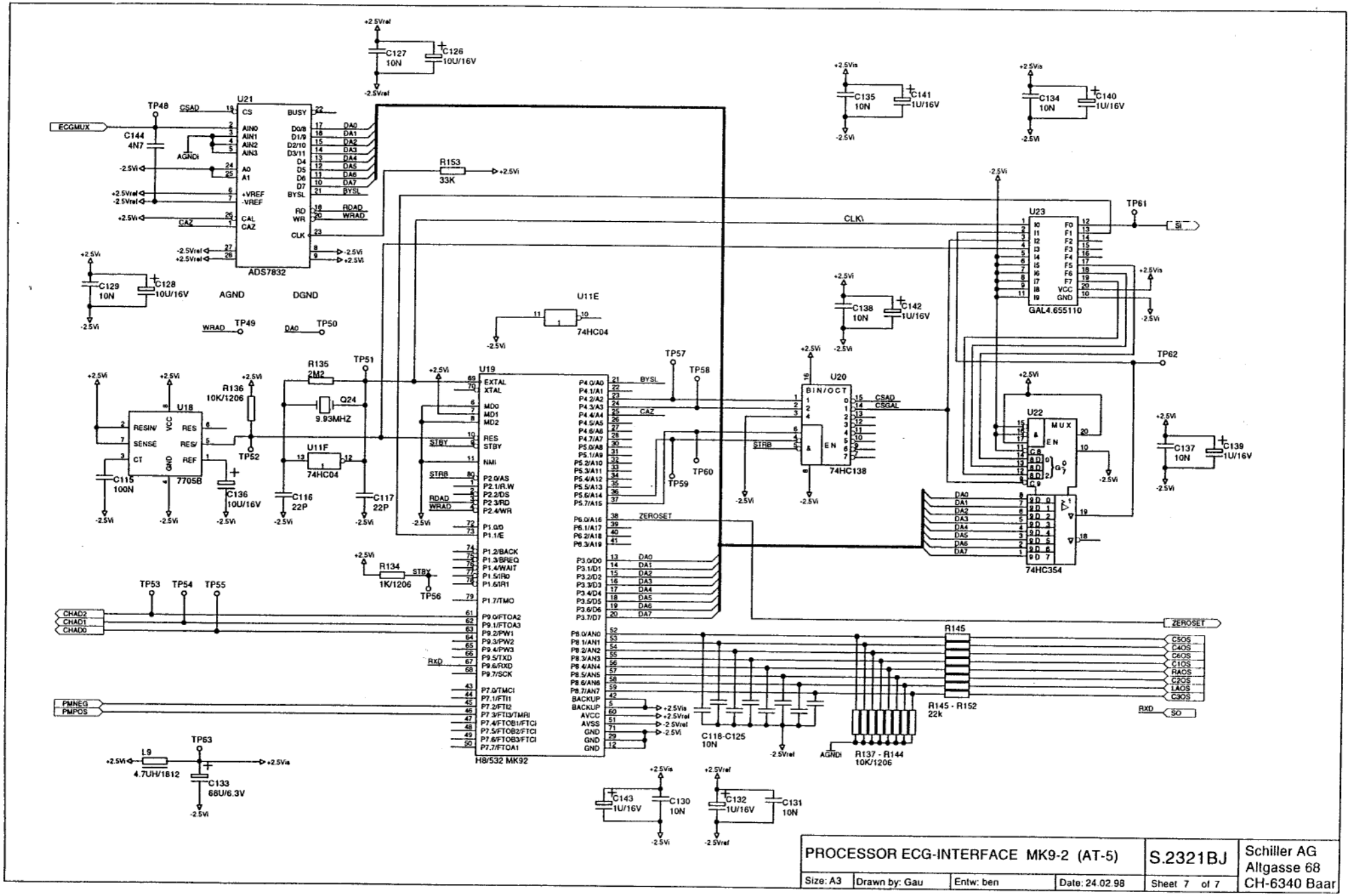
Schiller AG
Altgasse 68
CH-6340 Baar
Size: A3
Drawn by: Gau
Entw: ben
Date: 24.02.98
Sheet 6 of 7
DSUB-15W-90
MUX-08
ECGMUX
CHAD2
CHAD1
CHAD0
ZEROSET
TP47
C6OS
C5OS
C4OS
C3OS
C2OS
C1OS
LAOS
RAOS
5 X 100N
5 X 100N


U21
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U19
H8/532 MK92
U18
7705B
U20
74HC138
U22
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U23
GAL4.655110
U11E
74HC04
U11F
74HC04
TP48
TP49
TP50
TP51
TP52
TP53
TP54
TP55
TP56
TP57
TP58
TP59
TP60
TP61
TP62
ECGMUX
CSAD
CAZ
WRAD
DA0
CLK\
STBY
STRB
RDAD
WRAD
ZEROSET
RXD
PMNEG
PMPOS
CHAD2
CHAD1
CHAD0
AGND
DGND
R153
33K
R135
2M2
R136
10K/1206
R134
1K/1206
R145
R145 - R152
22k
R137 - R144
10K/1206
Q24
9.93MHZ
L9
4.7UH/1812
C118-C125
10N
PROCESSOR ECG-INTERFACE MK9-2 (AT-5)
S.2321BJ
Schiller AG
Altgasse 68
CH-6340 Baar
Size: A3
Drawn by: Gau
Entw: ben
Date: 24.02.98
Sheet 7 of 7

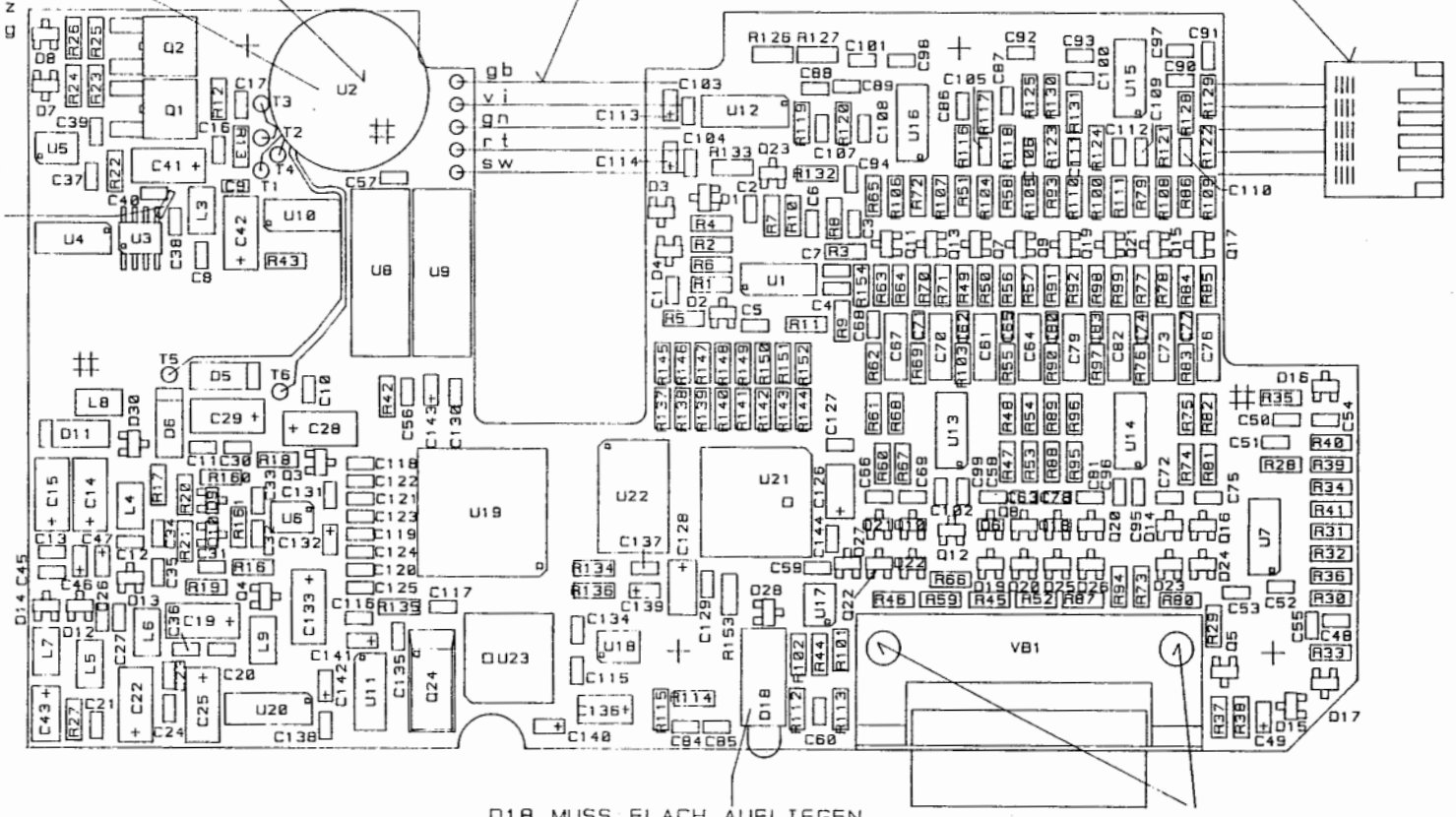
ANSCHLUESSE U2
T1: rt, kurz
T2: rt, lang
T3: or, kurz
T4: or, lang
T5: gb
T6: gb

MIT SCHRAUBE M1,6
VON LOETSEITE
BEFESTIGEN

KABEL AUF PRINTOBER-
SEITE EINLOETEN.

KABEL
ART.NR. 4.520 391

C200 ZWISCHEN U3 PIN 5
UND C40 EINLOETEN

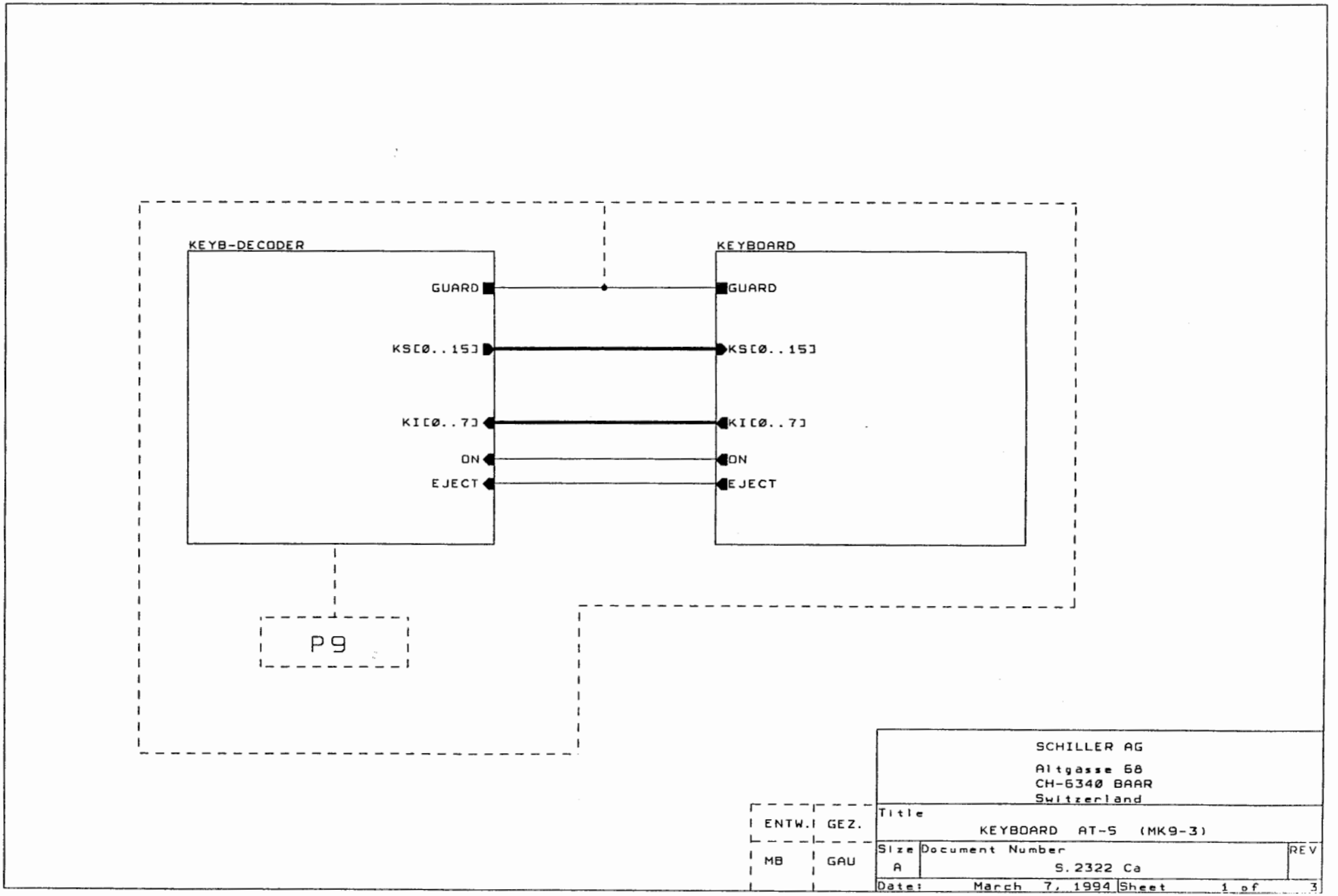


D18 MUSS FLACH AUFLIEGEN.

ALLE PINS AUF LOETSEITE
AUF 0,5 MM KUERZEN.
(EMV-KURZSCHLUSSGEFAHR)

SCHRAUBE M2.5 LOETSEITE
MUTTER BESTUECKUNGSSEITE
U-SCHEIBE UNTER FAECHERSCHEIBE.

SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : STR. Entw : Prod :
Title ECG-INTERFACE MK9-2		BAUTEILESEITE AT-5
Size Document Number D.2321BI		



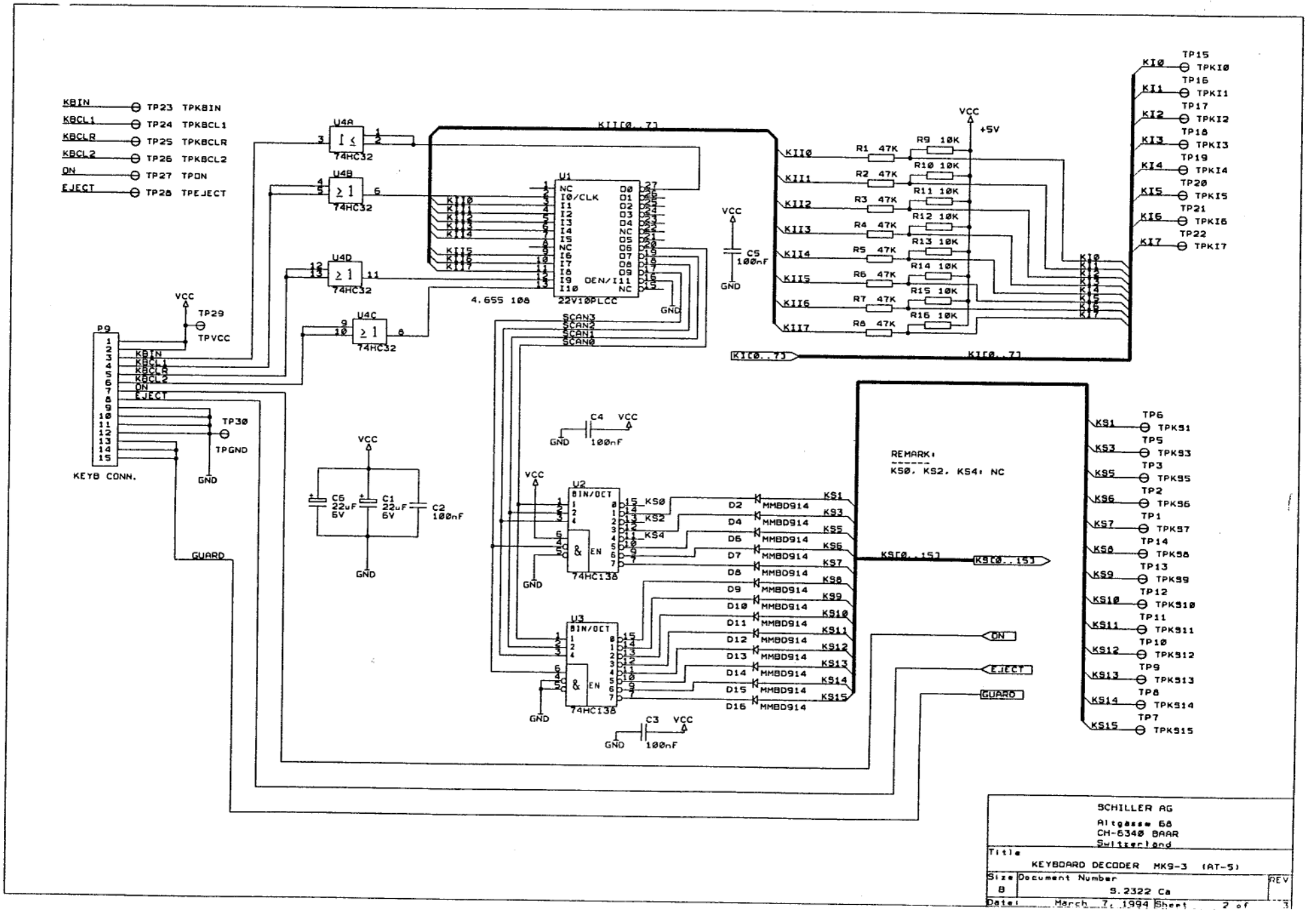
SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland

ENTW.	GEZ.
MB	GAU

Title: KEYBOARD AT-S (MK9-3)

Size	Document Number	REV
A	S.2322 Ca	

Date: March 7, 1994 Sheet 1 of 3

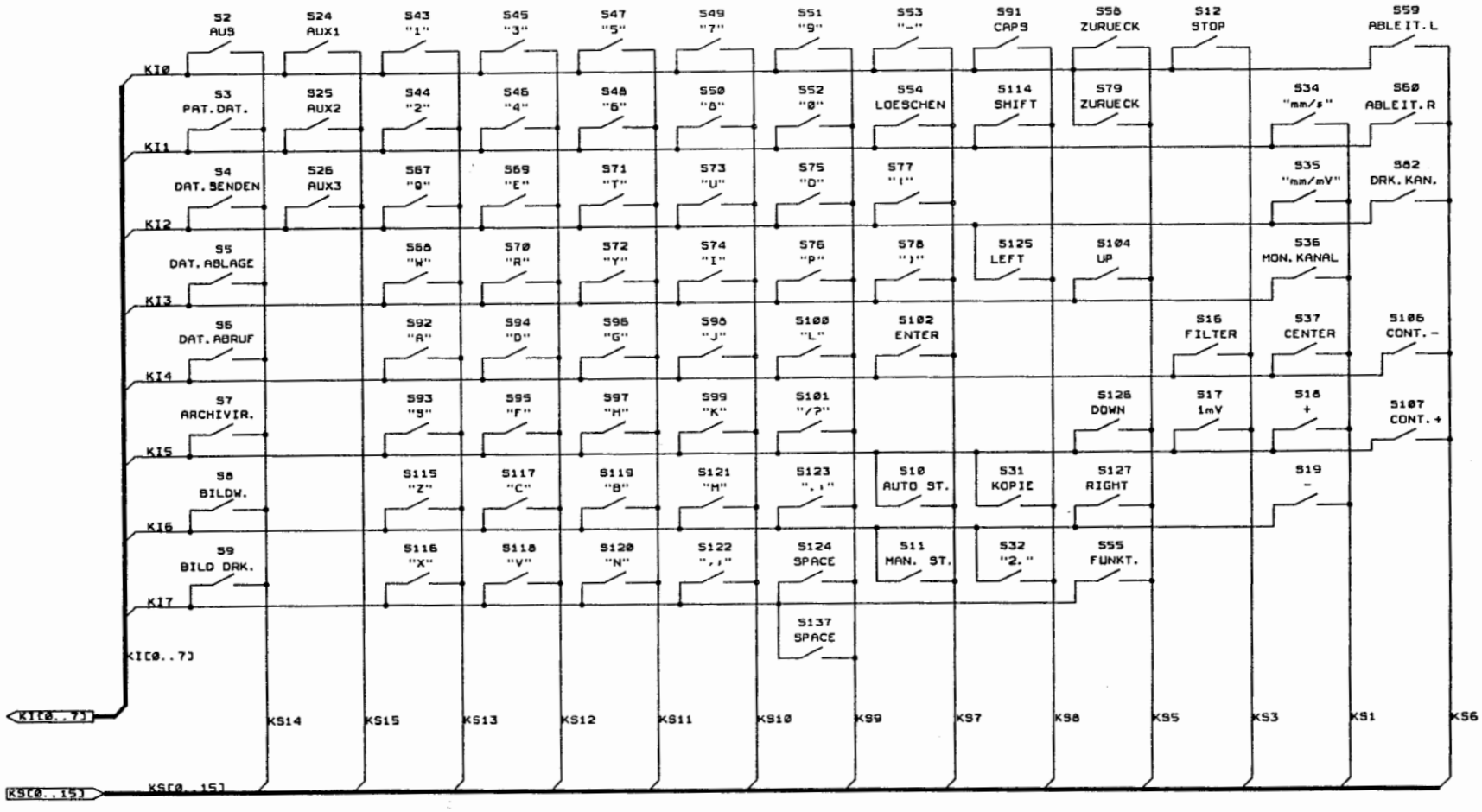


SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland

Title
KEYBOARD DECODER MK9-3 (AT-5)

Size	Document Number	REV
B	9.2322 Ca	

Date: March 7, 1994 Sheet 2 of 3



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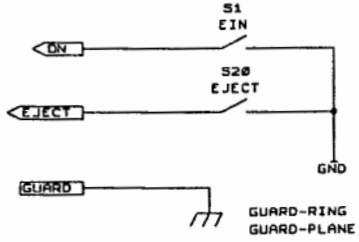
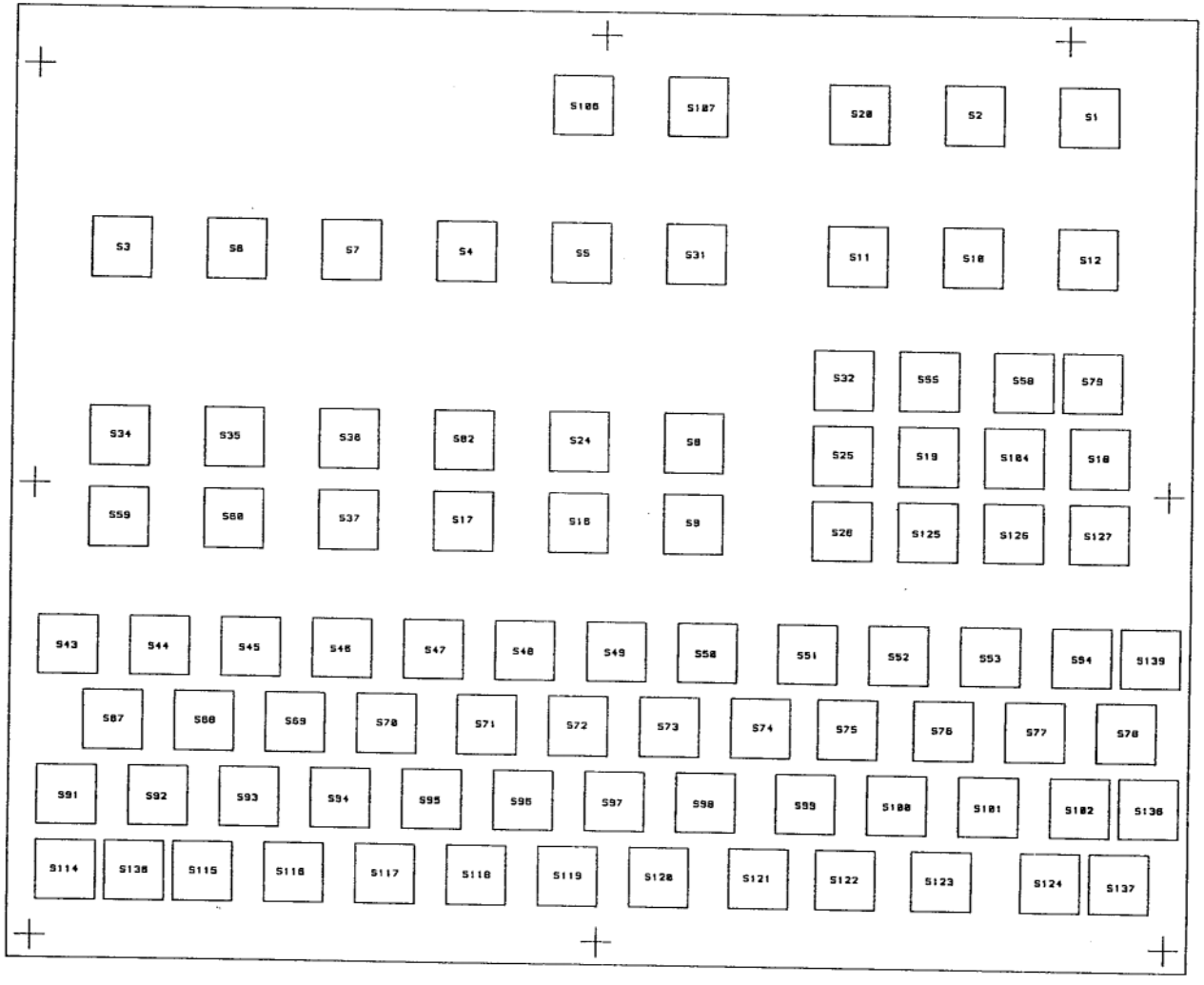


SCHILLER AG
Altgasse 68
CH-6340 Baar
Switzerland

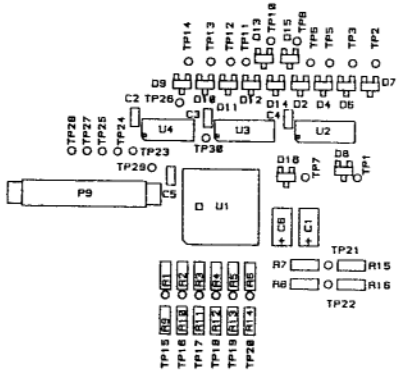
Title: KEYBOARD MK9-3 (AT-S)

Size: B | Document Number: 9.2322 Ca | REV:

Date: March 7, 1994 | Sheet 3 of 3



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : Gau Entw : Prod :
Title KEYBOARD MK9-3		AT-S
Size	Document Number D.2322Ba	
Date: 17.06.93	Sheet	1 of 2



ESD

KLEBER MIT ARTIKELNUMMER

TP9

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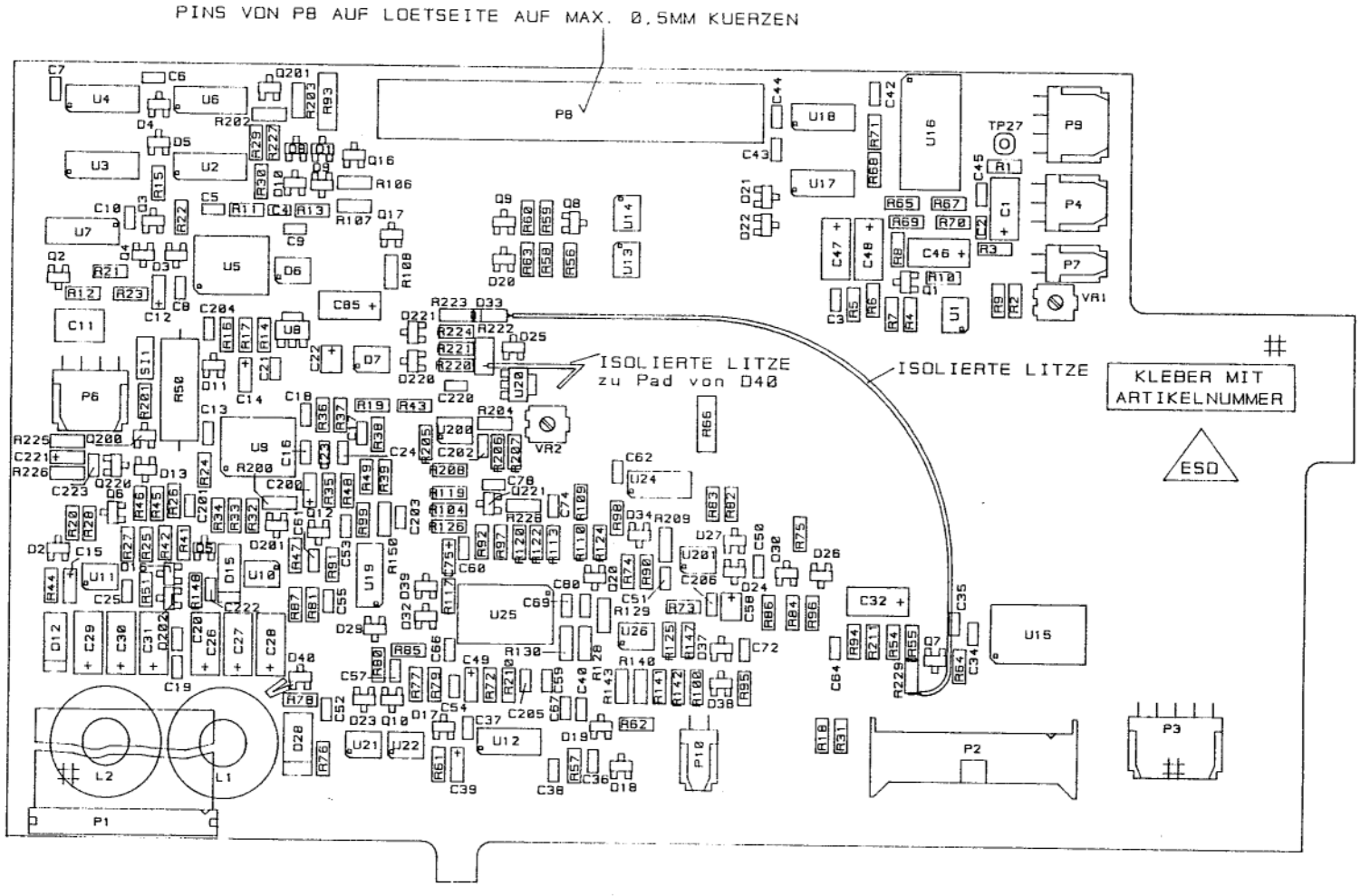
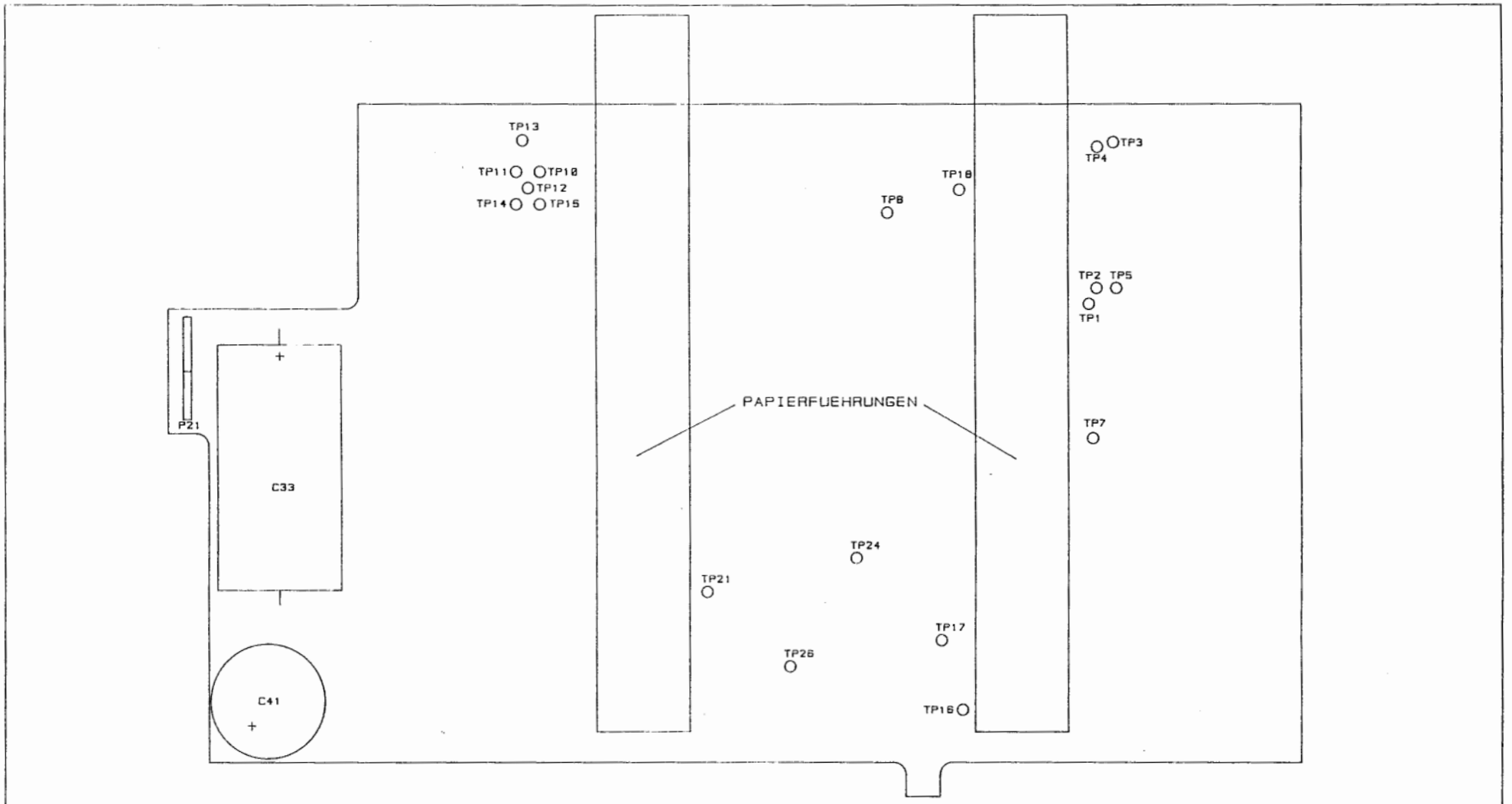
SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : Gau Entw : Prod :
Title KEYBOARD MK9-3		AT-5
Size	Document Number D.2322Ba	
Date: 17.06.93	Sheet	2 of



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : Gau Entw : 4.6.L Prod :
Title PRINTER-INTERFACE MK9-5		AT-5
Size	Document Number D.23260F	



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Title PRINTER-INTERFACE MK9-5		AT-5
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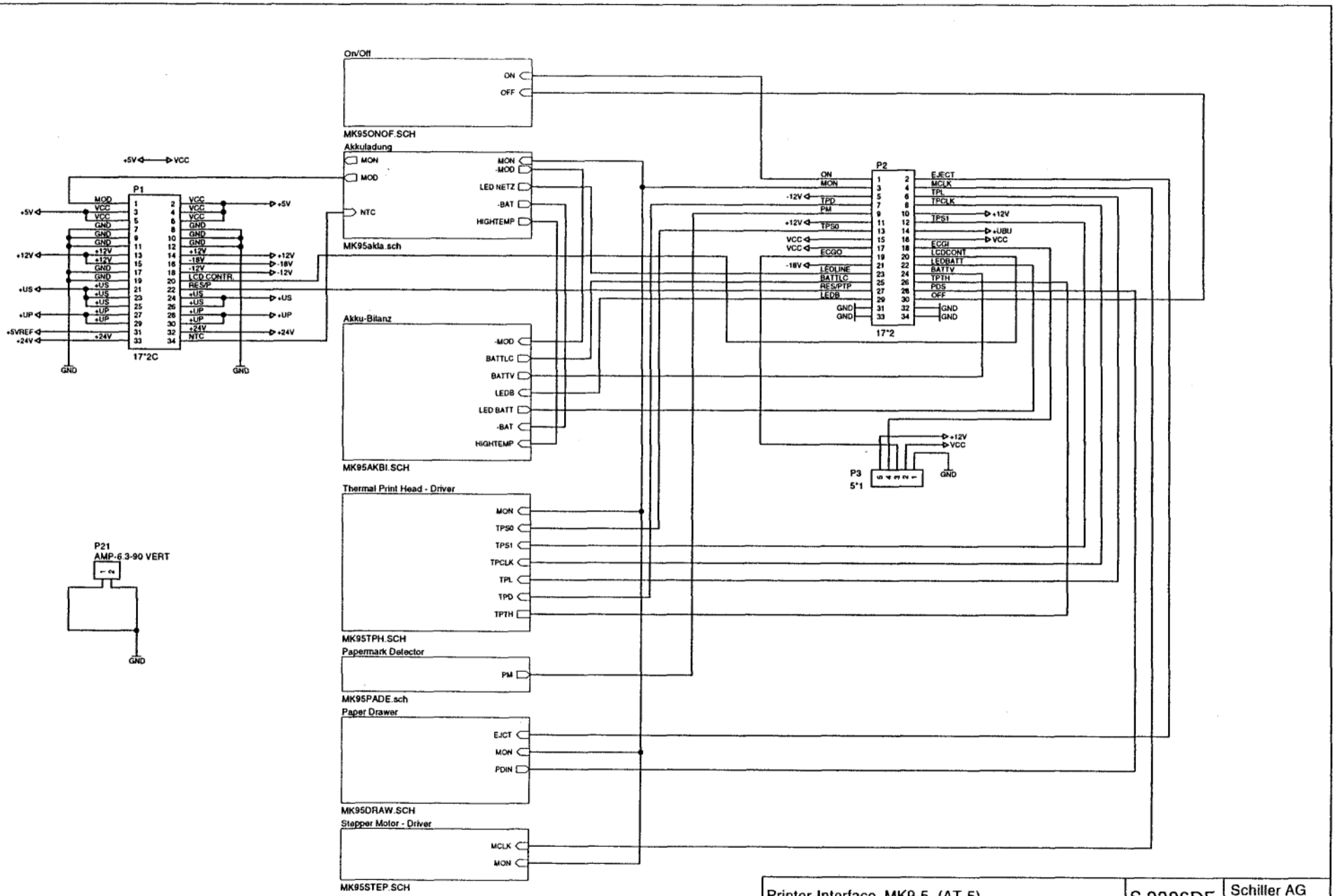

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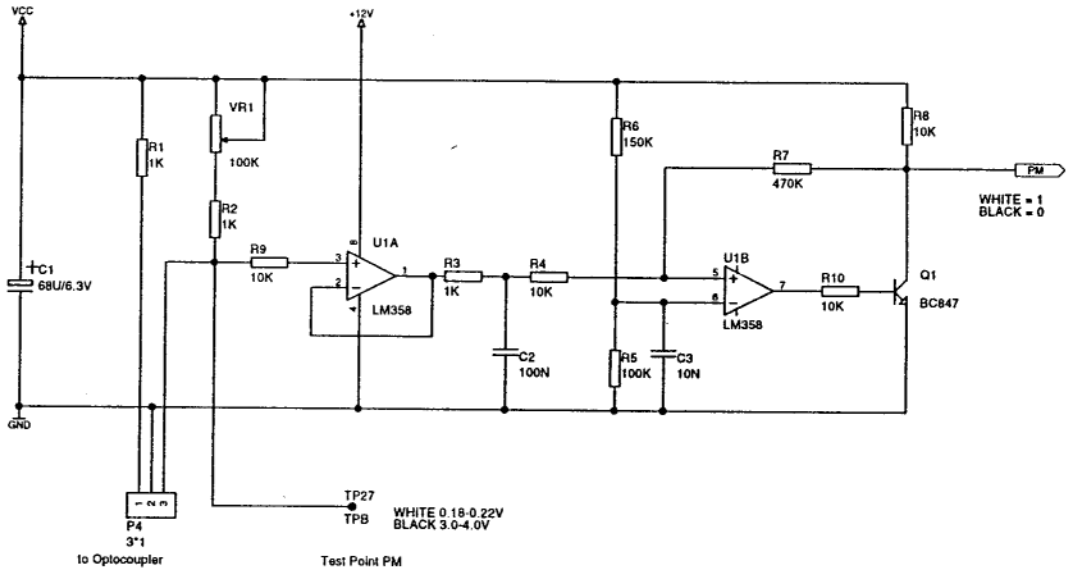
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 1 of 8	



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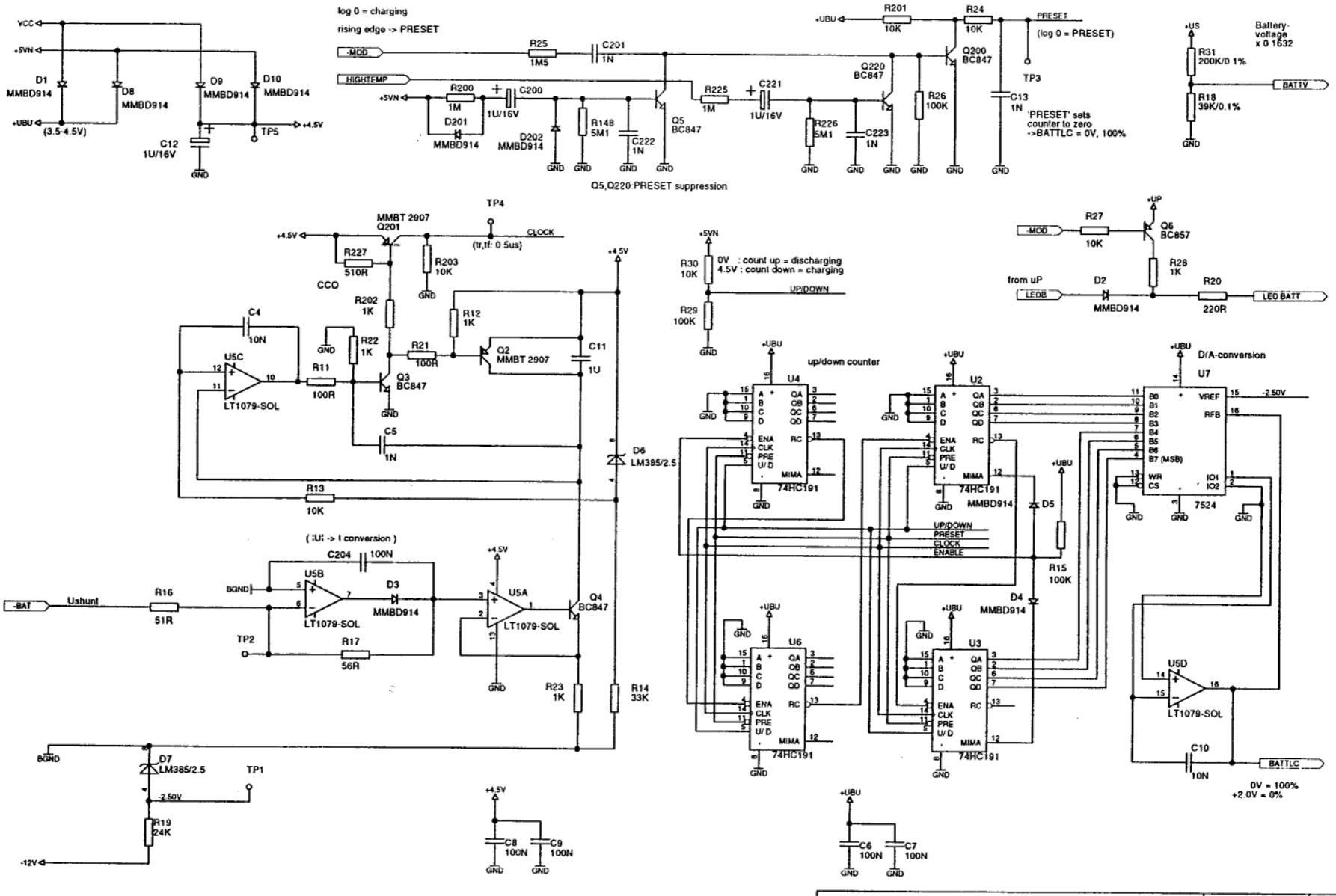
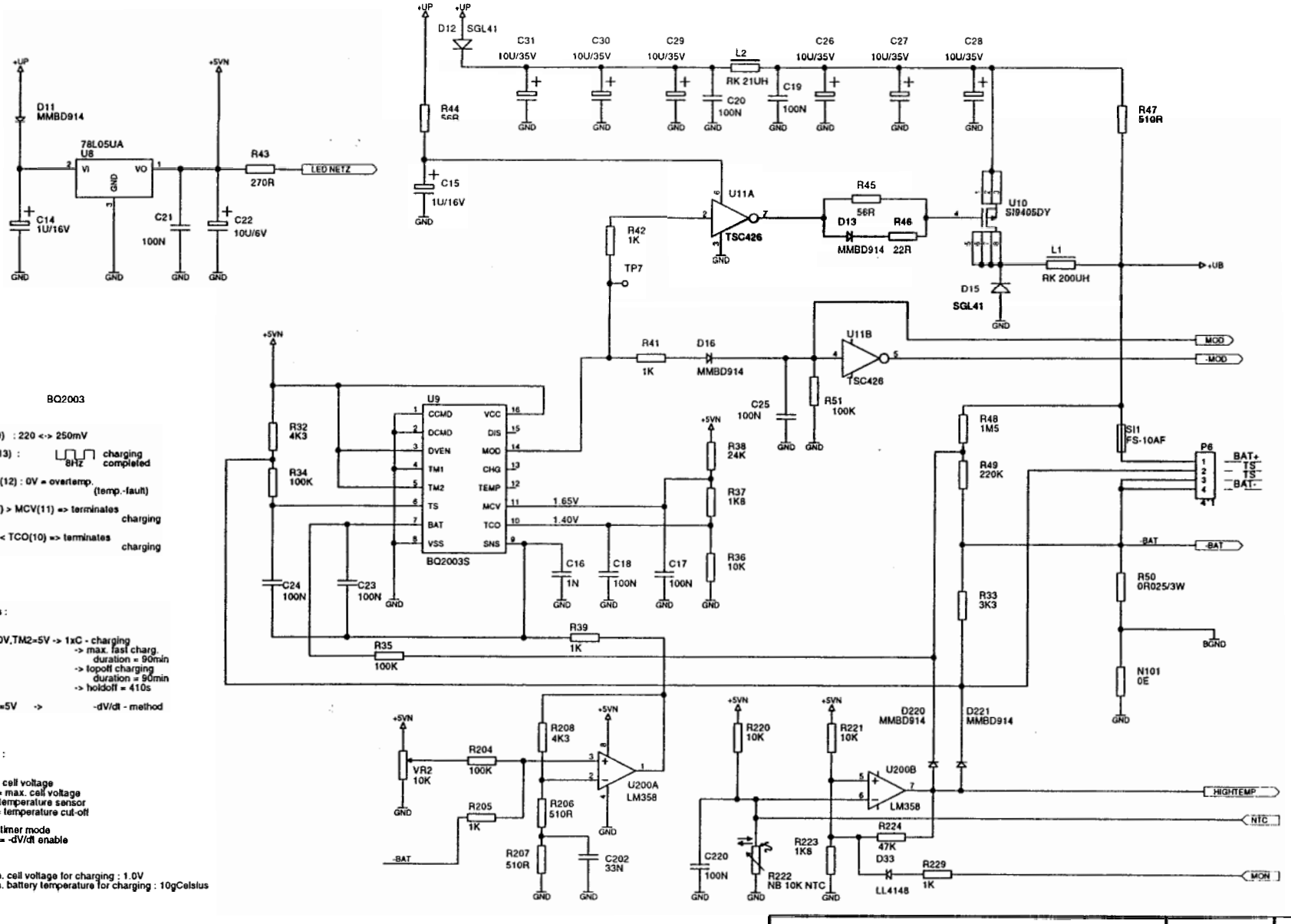
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 2 of 8	



Akku-Bilanz MK9-5 (AT-5)				S.2326DF	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 3 of 8	



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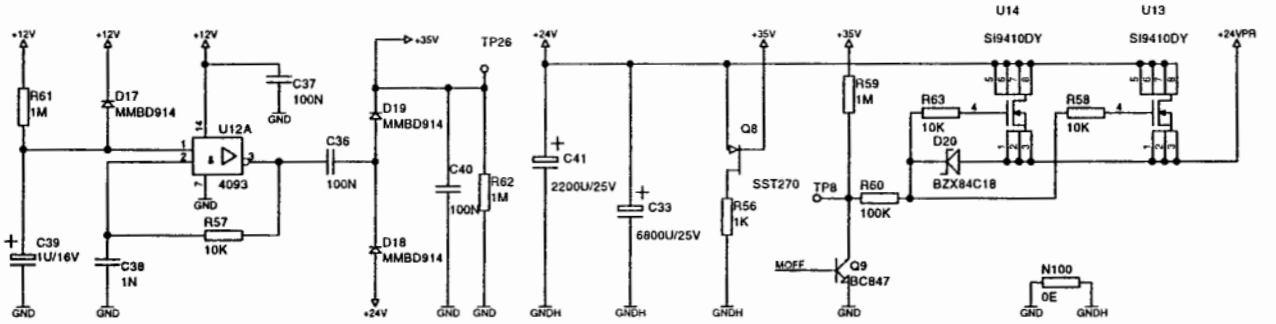
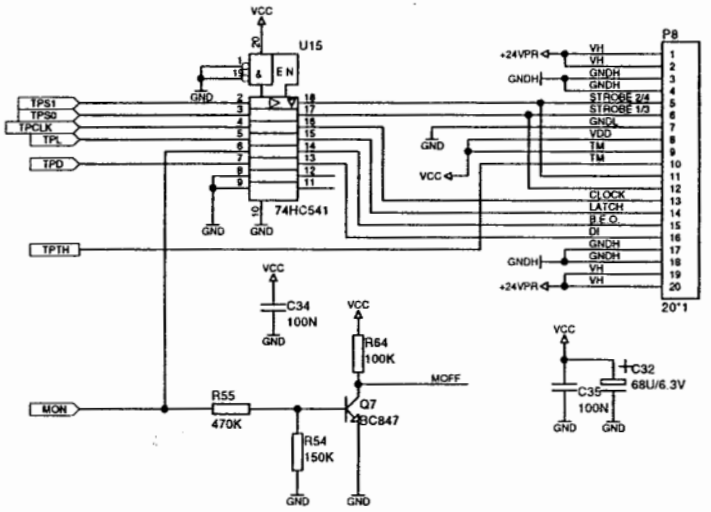
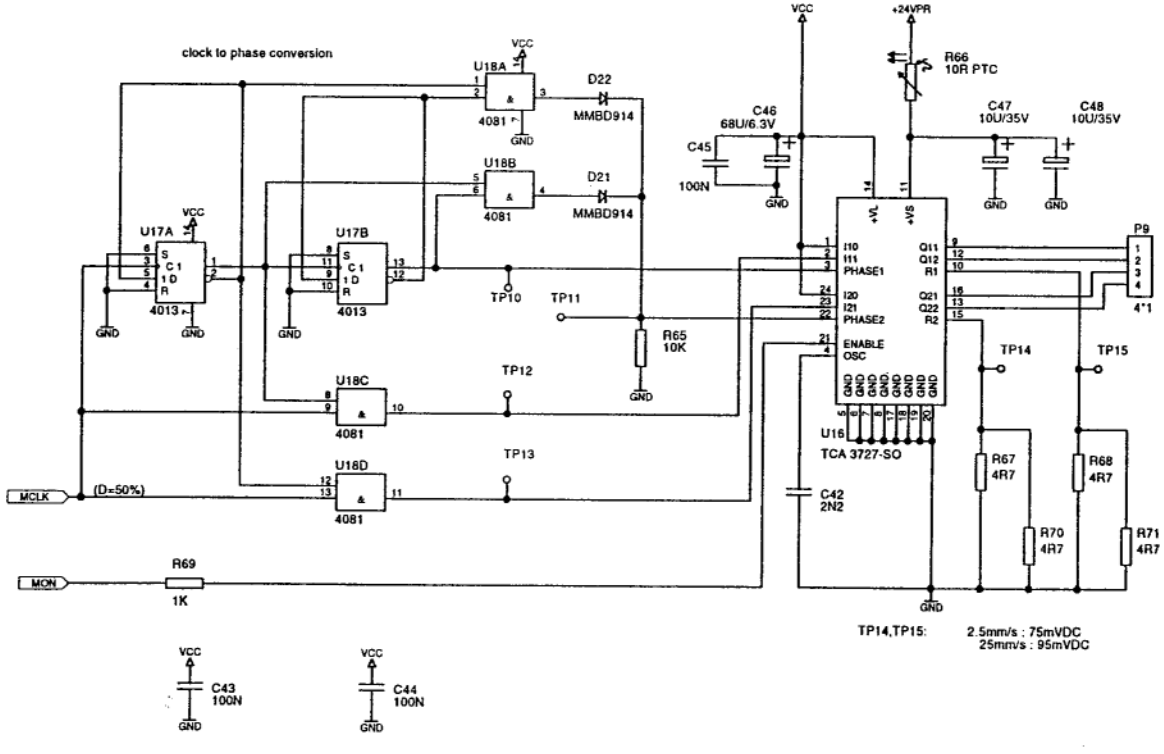
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 4 of 8	

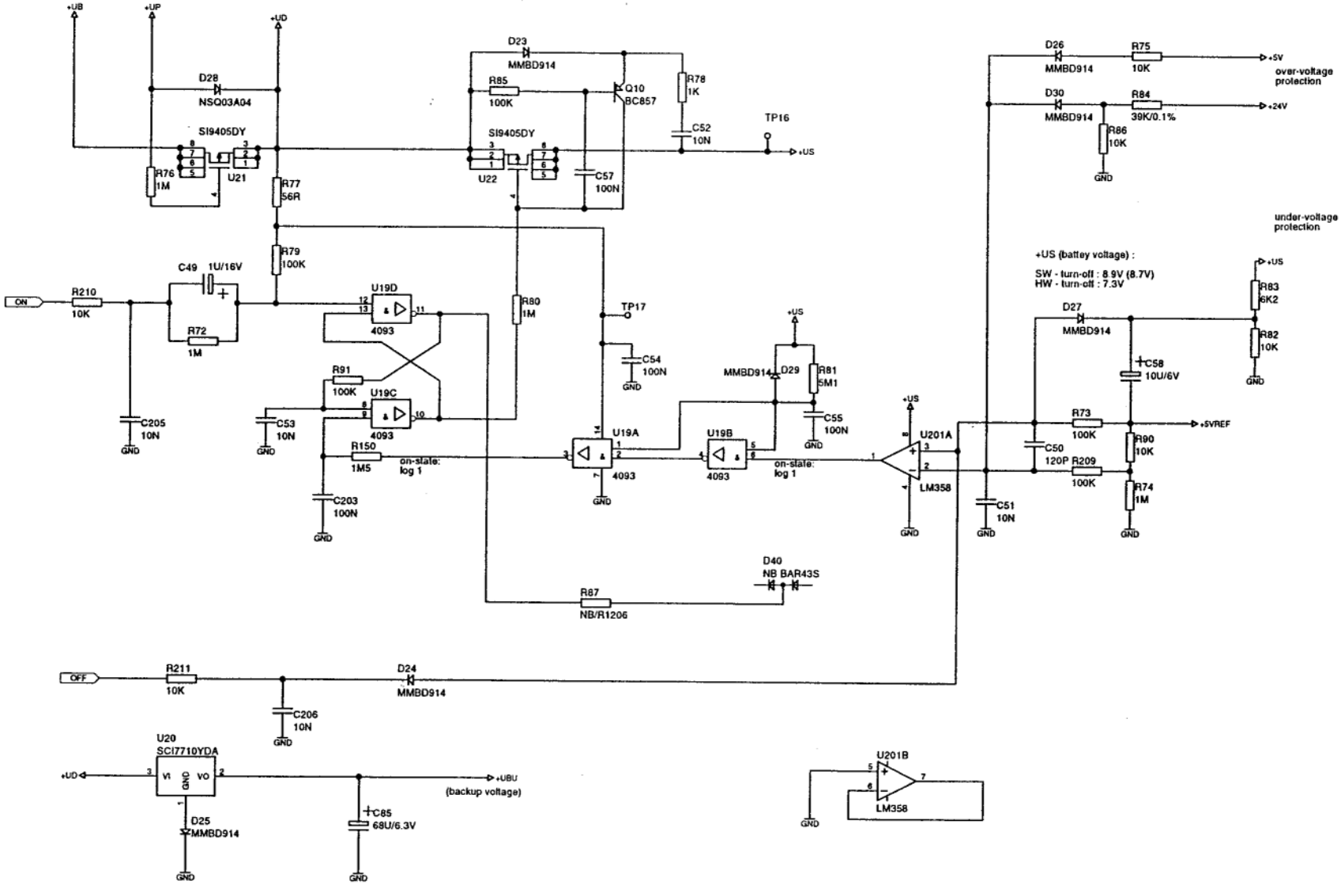




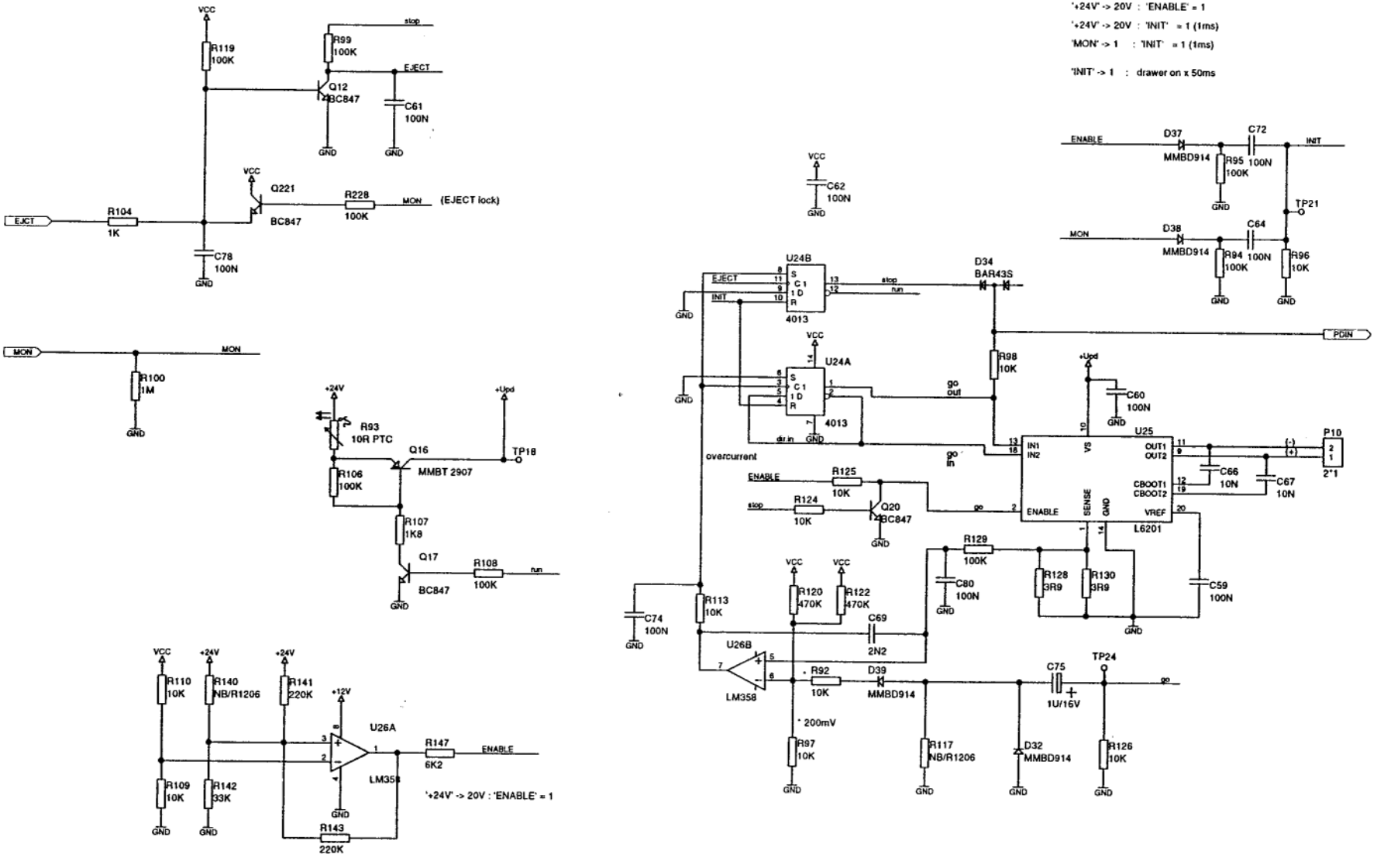
Thermal Print Head-Driver MK9-5 (AT-5)				S.2326DF	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 5 of 8	



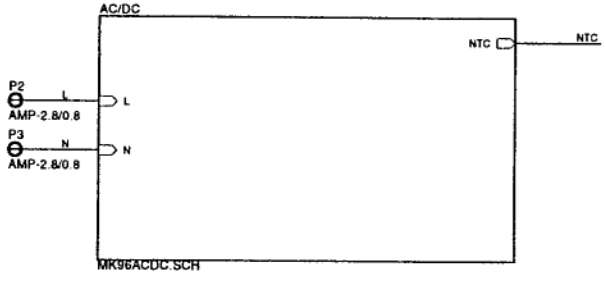
Stepper Motor - Driver MK9-5 (AT-5)				S.2326DF	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 6 of 8	

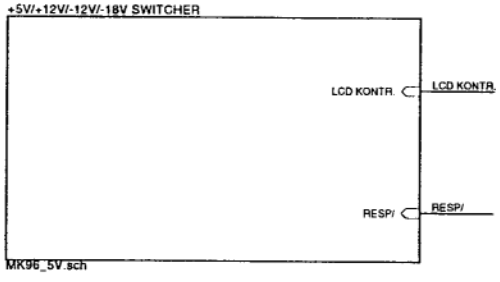


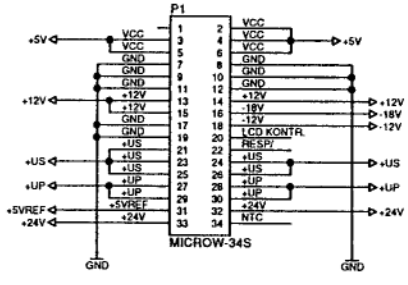
ON/OFF & BACKUP MK9-5 (AT-5)				S.2326DF	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 7 of 8	

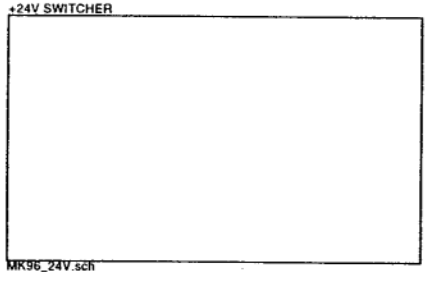


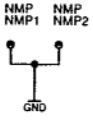
Paperdrawer MK9-5 (AT-5)				S.2326DF	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HSch	Date: 27.01.97	Sheet 8 of 8	



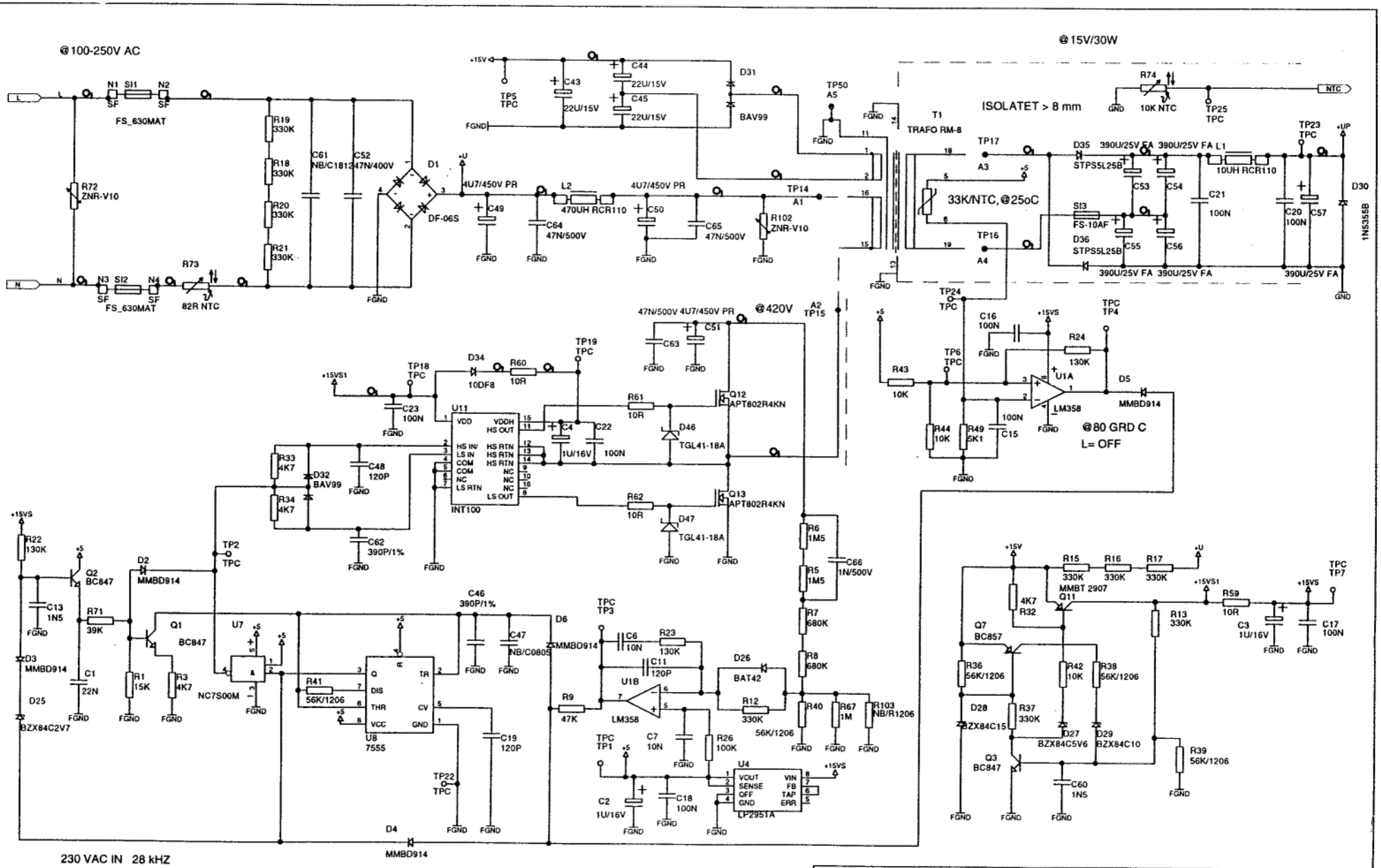


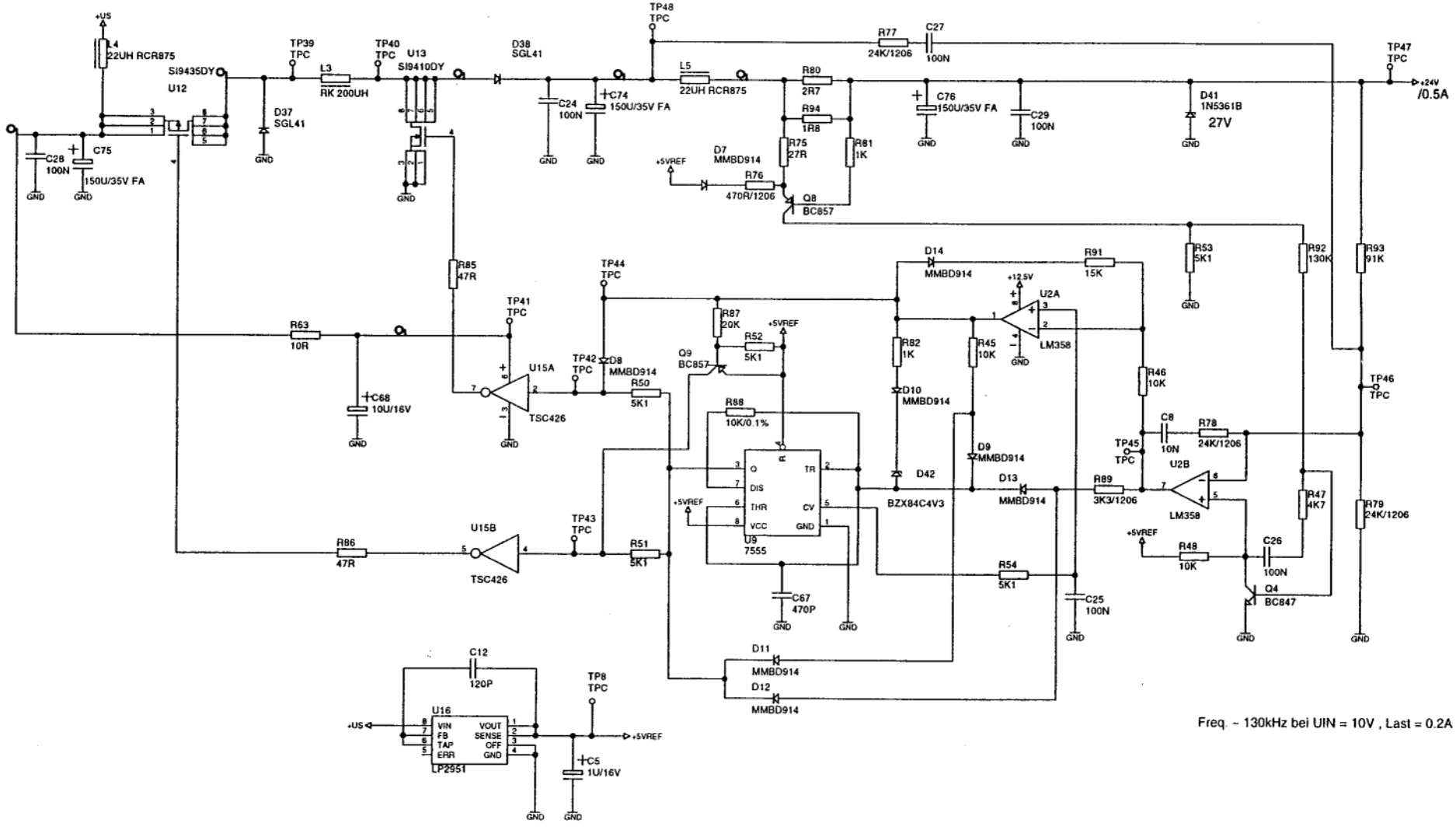






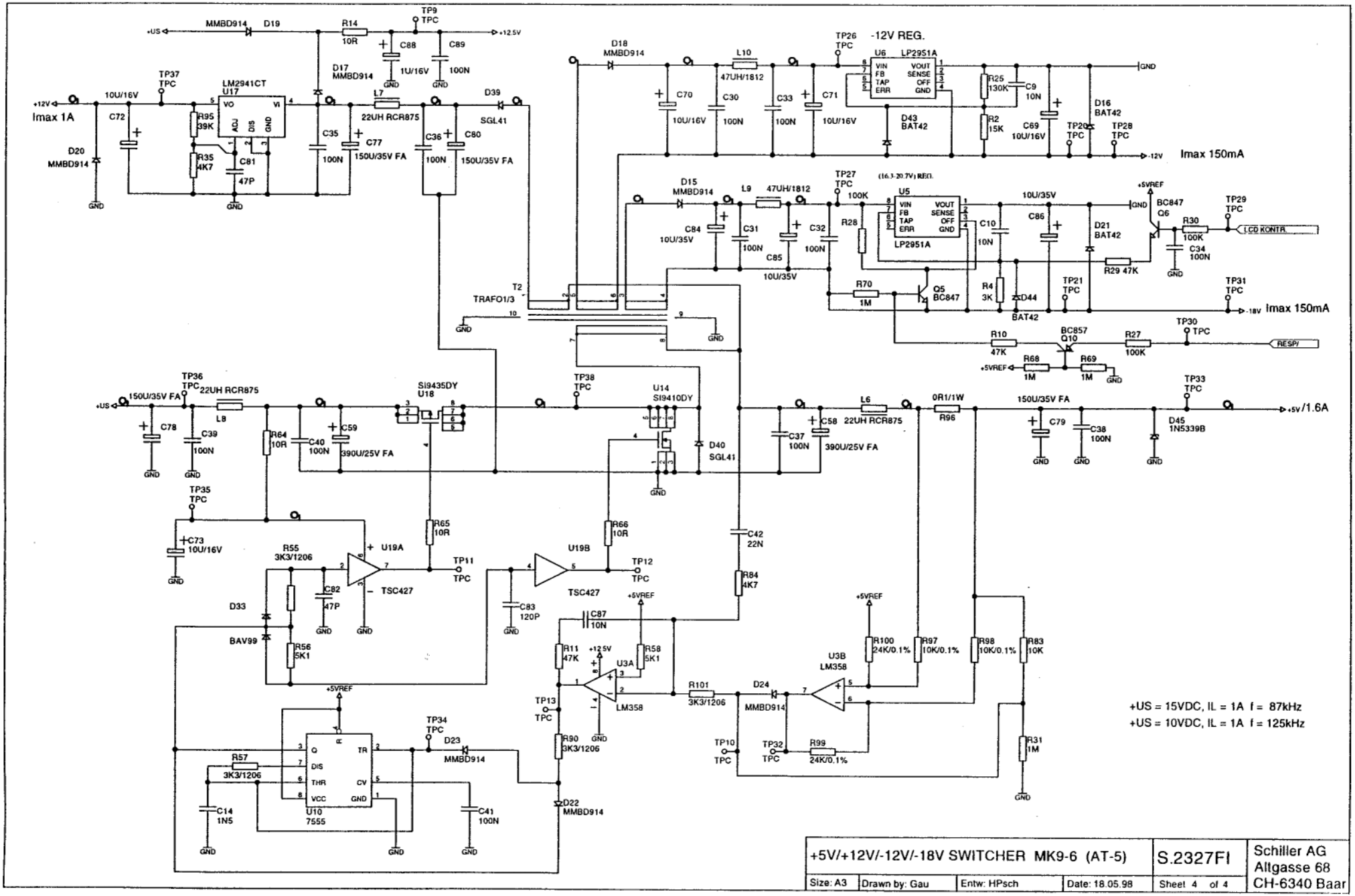
POWER SUPPLY MK9-6 (AT-5)				S.2327FI	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HPsch	Date: 18.05.98	Sheet 1 of 4	

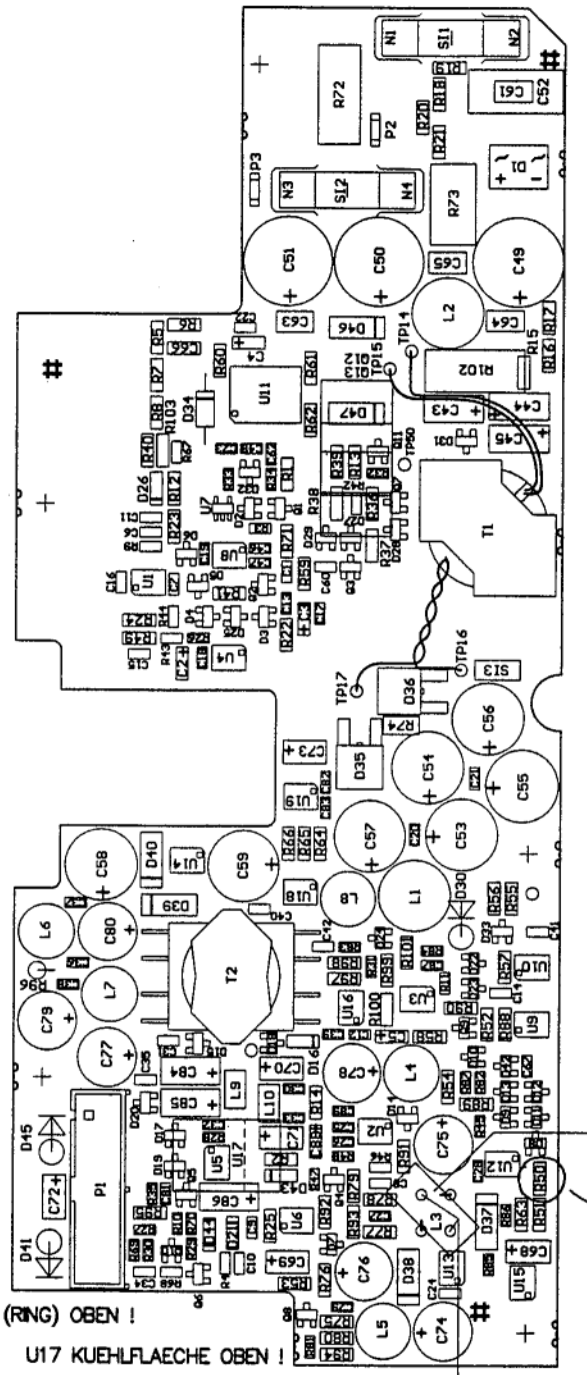

@100-250V AC
@15V/30W
ISOLATET > 8 mm
@420V
@80 GRD C
L= OFF
33K/NTC,@25oC
FS_630MAT
82R NTC
TRAFO RM-8
INT100
NC7S00M
LM358
LP295TA
7555
MMBD914
BAV99
BAT42
BC847
BC857
MMBT 2907
APT802R4KN
TGL41-18A
DF-06S
10DF8
1N5355B
STPS5L25B
10K NTC
470UH RCR110
10UH RCR110
230 VAC IN 28 kHZ
100 VAC IN 40 kHz
AC/DC MK 9-6 (AT-5)
S.2327FI
Size: A3
Drawn by: Gau
Entw: HPsch
Date: 18.05.98
Sheet 2 of 4
Schiller AG
Altgasse 68
CH-6340 Baar



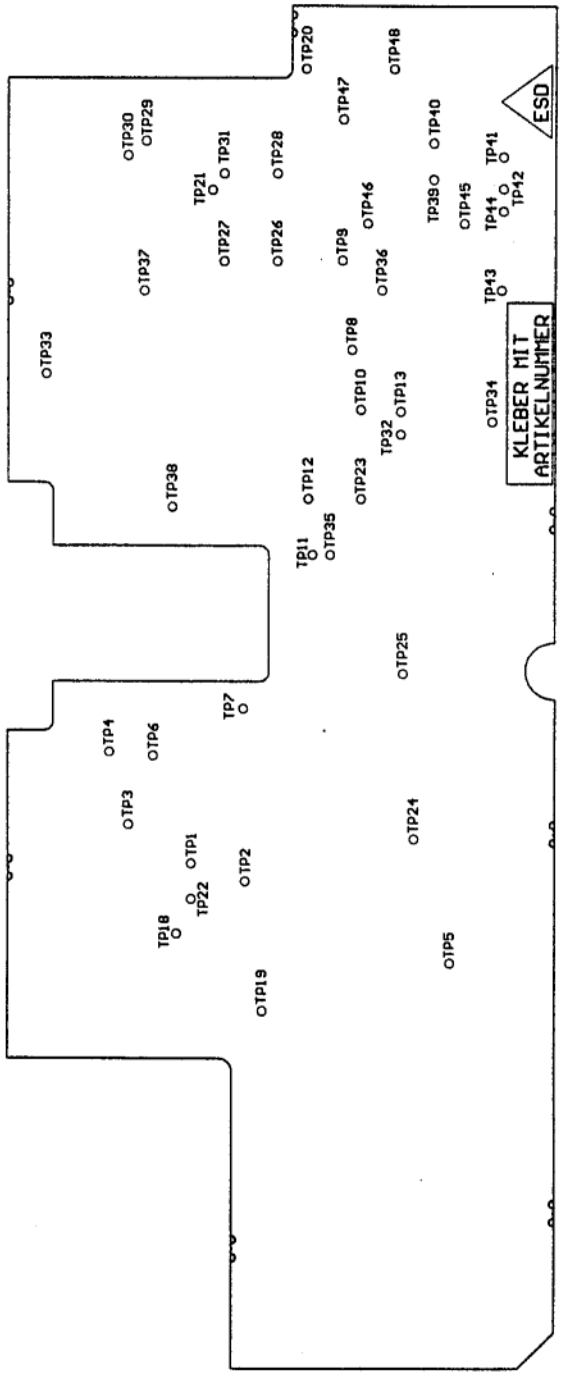
Freq. ~ 130kHz bei UIN = 10V , Last = 0.2A

+24V SWITCHER MK9-6 (AT-5)				S.2327FI	Schiller AG Altgasse 68 CH-6340 Baar
Size: A3	Drawn by: Gau	Entw: HPsch	Date: 18.05.98	Sheet 3 of 4	

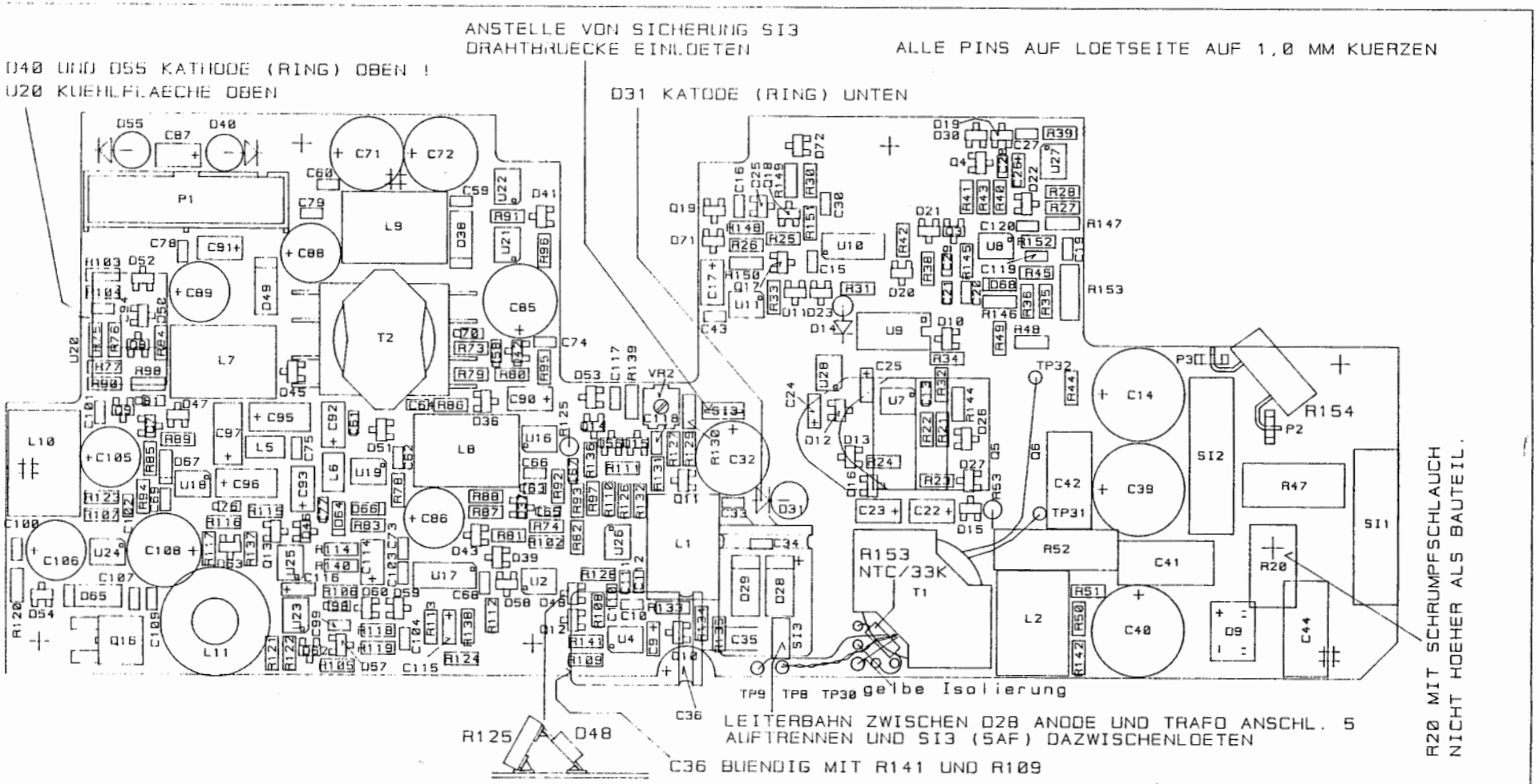

+US
MMBD914
D19
R14
10R
TP9
TPC
+12.5V
C88
1U/16V
C89
100N
D17
MMBD914
TP37
TPC
+12V
10U/16V
LM2941CT
U17
VO
VI
ADJ
DIS
GND
Imax 1A
C72
R95
39K
R35
4K7
C81
47P
D20
MMBD914
C35
100N
C77
150U/35V FA
L7
22UH RCR875
C36
100N
C80
150U/35V FA
D39
SGL41
D18
MMBD914
L10
47UH/1812
TP26
TPC
-12V REG.
U6
LP2951A
VIN
FB
TAP
ERR
VOUT
SENSE
OFF
GND
C70
10U/16V
C30
100N
C33
100N
C71
10U/16V
D43
BAT42
R25
130K
C9
10N
R2
15K
C69
10U/16V
D16
BAT42
TP20
TPC
TP28
TPC
-12V
Imax 150mA
D15
MMBD914
L9
47UH/1812
TP27
TPC
(16.3-20.7V) REG.
100K
U5
LP2951A
C84
10U/35V
C31
100N
C85
10U/35V
C32
100N
R28
C10
10N
10U/35V
C86
D21
BAT42
+5VREF
BC847
Q6
R30
100K
C34
100N
TP29
TPC
LCD KONTR.
R29 47K
T2
TRAFO1/3
R70
1M
Q5
BC847
R4
3K
D44
BAT42
TP21
TPC
TP31
TPC
-18V
Imax 150mA
TP30
TPC
R10
47K
BC857
Q10
R27
100K
RESPY
R68
1M
R69
1M
TP36
TPC
150U/35V FA
22UH RCR875
L8
C78
C39
100N
R64
10R
C40
100N
C59
390U/25V FA
SI9435DY
U18
TP38
TPC
U14
SI9410DY
D40
SGL41
C37
100N
C58
390U/25V FA
L6
22UH RCR875
0R1/1W
R96
150U/35V FA
C79
C38
100N
D45
1N5339B
TP33
TPC
+5V/1.6A
TP35
TPC
C73
10U/16V
R55
3K3/1206
U19A
TSC427
TP11
TPC
R65
10R
U19B
TSC427
TP12
TPC
R66
10R
C42
22N
R84
4K7
C82
47P
C83
120P
D33
BAV99
R56
5K1
C87
10N
+5VREF
R11
47K
+12.5V
U3A
LM358
R58
5K1
TP13
TPC
R90
3K3/1206
R101
3K3/1206
D24
MMBD914
U3B
LM358
R100
24K/0.1%
R97
10K/0.1%
R98
10K/0.1%
R83
10K
TP10
TPC
TP32
TPC
R99
24K/0.1%
R31
1M
TP34
TPC
D23
MMBD914
R57
3K3/1206
U10
7555
Q
TR
DIS
THR
CV
VCC
GND
C14
1N5
C41
100N
D22
MMBD914
+US = 15VDC, IL = 1A f = 87kHz
+US = 10VDC, IL = 1A f = 125kHz
+5V/+12V/-12V/-18V SWITCHER MK9-6 (AT-5)
S.2327FI
Schiller AG
Allgasse 68
CH-6340 Baar
Size: A3
Drawn by: Gau
Entw: HPsch
Date: 18.05.98
Sheet 4 of 4



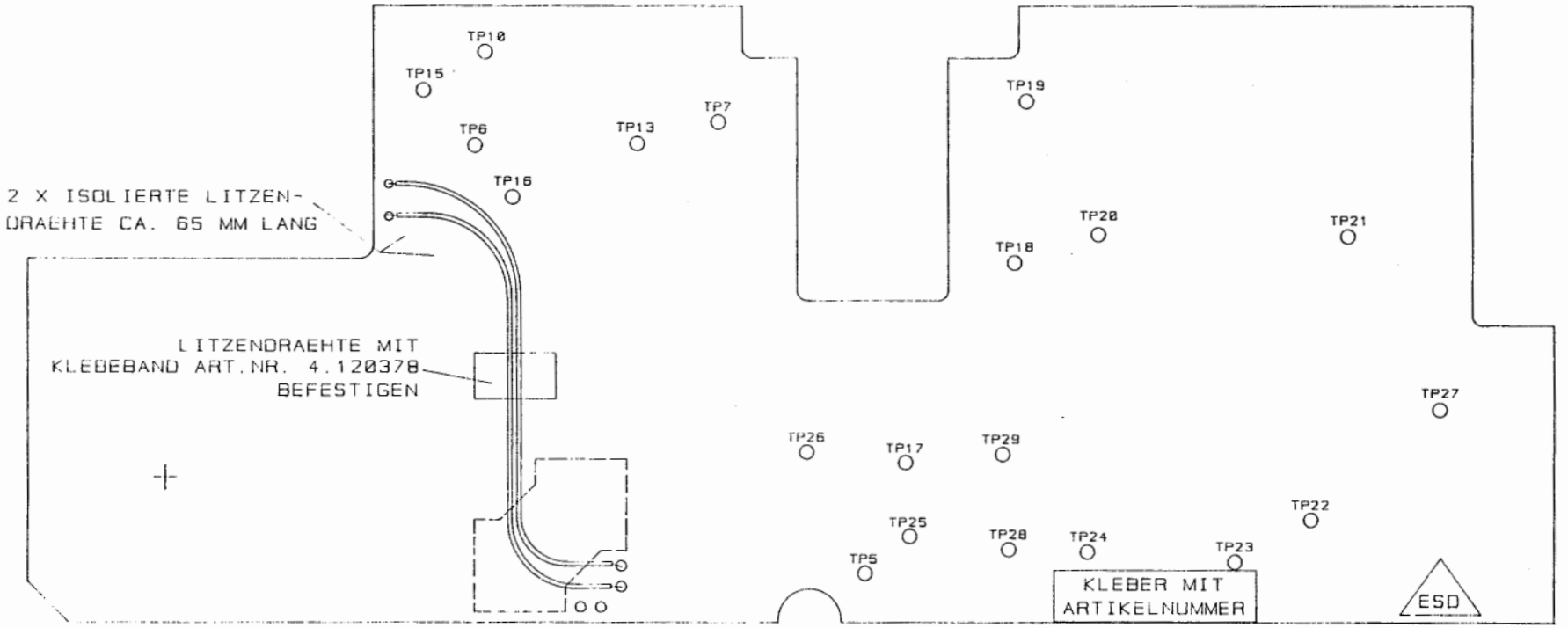
Title: POWER SUPPLY MK9-6				D.2327FD	Schiller AG Altgasse 68 CH-6340 Baar
Project: AT-5					
Visum:	Drawn By: STR	Entw.	Prod.	Date 29.09.97	Sheet 1 of 2



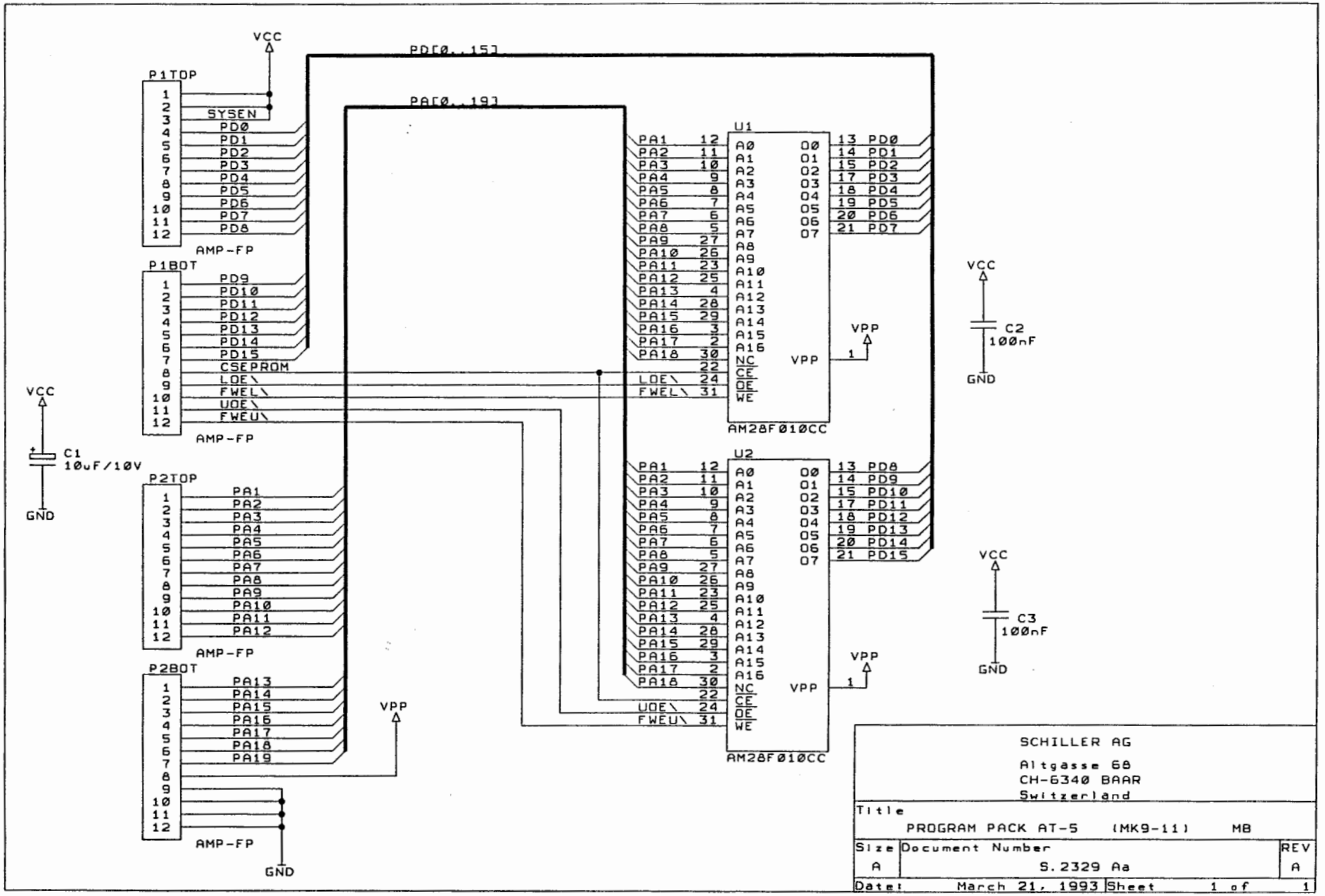
Title: POWER SUPPLY MK9–6				D.2327FD	Schiller AG Altgasse 68 CH–6340 Baar
Project: AT–5					
Visum:	Drawn By: STR	Entw.	Prod.	Date 29.09.97	Sheet 2 of 2



SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland		Visum Gez : STR. Entw : Prod :
Title POWER SUPPLY MK9-6		BAUTEILESEITE AT-5
Size	Document Number D.2327DH	



	SCHILLER AG Altgasse 68 CH-6340 Baar Switzerland	Visum Gez : STR. Entw : Prod :
Title POWER SUPPLY MK9-6		LOETSEITE AT-5
Size Document Number D.2327DH		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PD[0..15]
PA[0..19]
P1TOP
SYSEN
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
PD8
AMP-FP
P1BOT
PD9
PD10
PD11
PD12
PD13
PD14
PD15
CSEPROM
LOE\
FWEL\
UOE\
FWEU\
AMP-FP
P2TOP
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PA8
PA9
PA10
PA11
PA12
AMP-FP
P2BOT
PA13
PA14
PA15
PA16
PA17
PA18
PA19
AMP-FP
GND
VPP
U1
U2
AM28F010CC
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
NC
CE
OE
WE
O0
O1
O2
O3
O4
O5
O6
O7
C1
10uF/10V
C2
100nF
C3
100nF
SCHILLER AG
Altgasse 68
CH-6340 BAAR
Switzerland
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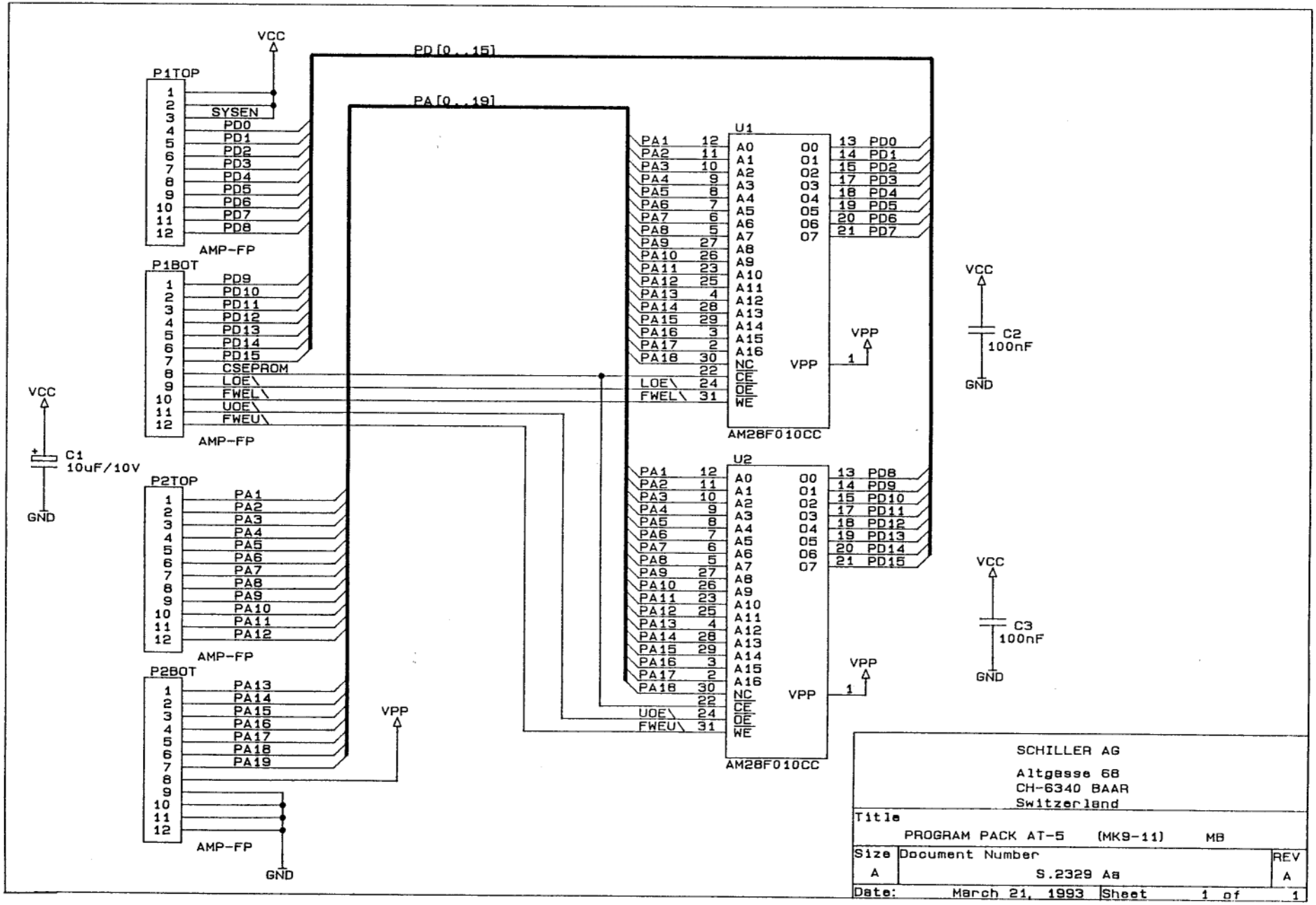
Size
A
Document Number
S.2329 Aa
REV
A
Date: March 21, 1993
Sheet 1 of 1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PD[0..15]
PA[0..19]
P1TOP
SYSEN
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
PD8
AMP-FP
P1BOT
PD9
PD10
PD11
PD12
PD13
PD14
PD15
CSEPROM
LOE\
FWEL\
UOE\
FWEU\
AMP-FP
P2TOP
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PA8
PA9
PA10
PA11
PA12
AMP-FP
P2BOT
PA13
PA14
PA15
PA16
PA17
PA18
PA19
AMP-FP
GND
VPP
C1
10uF/10V
U1
U2
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
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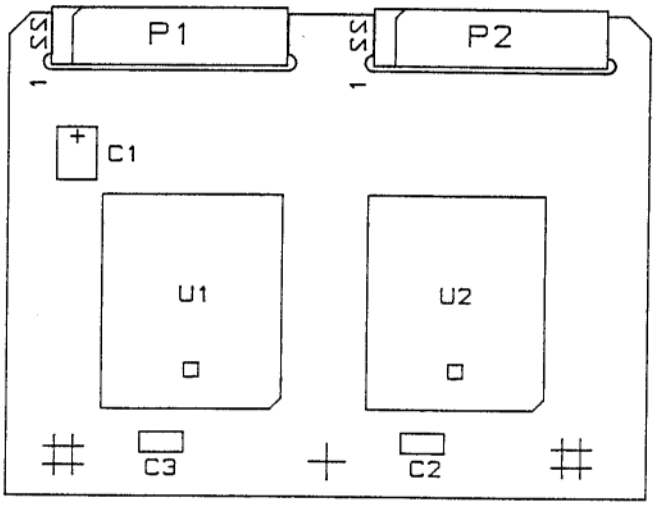
Date: March 21, 1993
Sheet 1 of 1

ARTIKELNUMMER UND ESD-SYMBOL
AUF LOETSEITE ANBRINGEN



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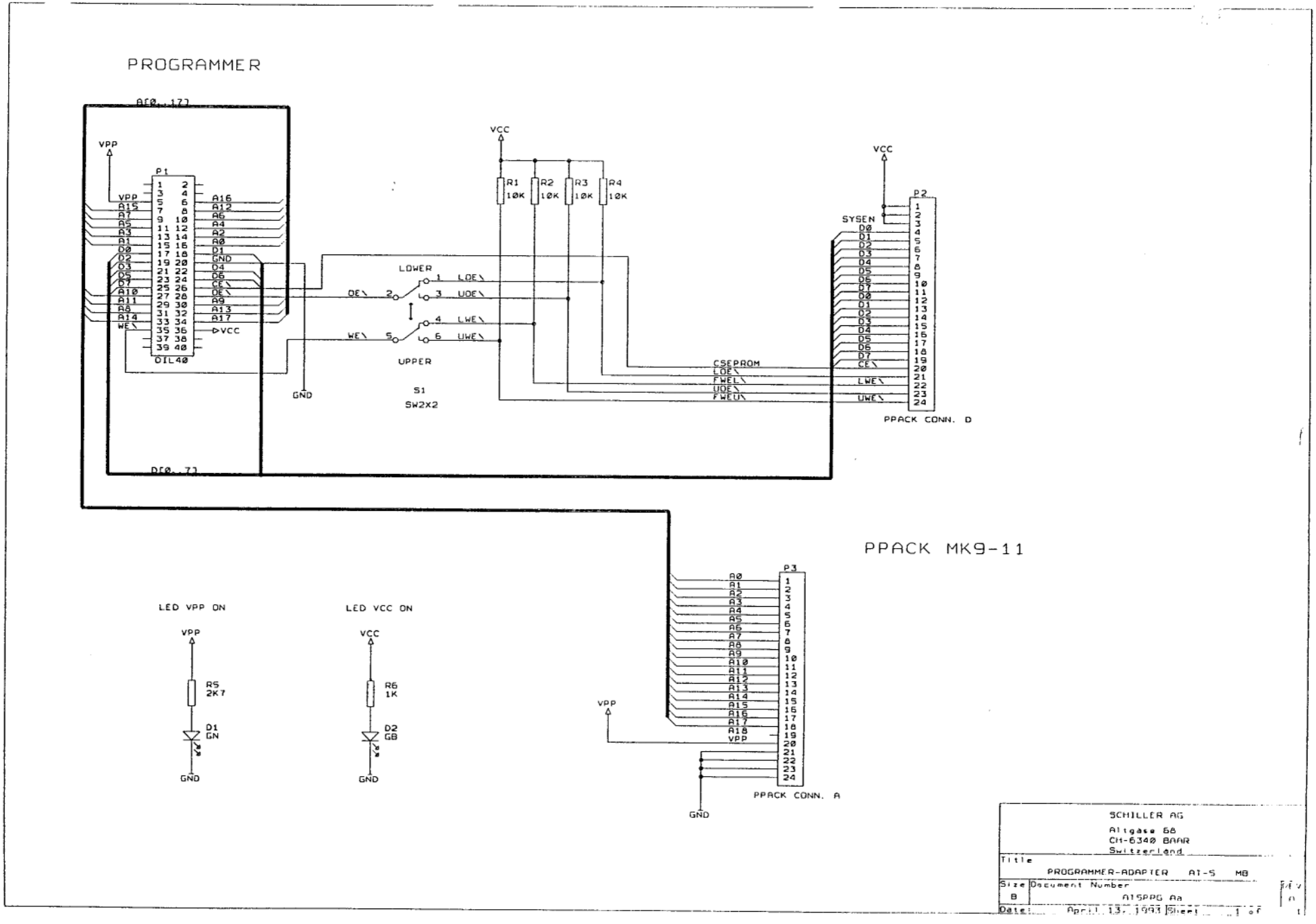
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P2
SYSEN
CSEPROM
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LED VCC ON
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R6 1K
D1 GN
D2 GB
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Size B
Document Number A1SPPG Aa
Rev A
Date: April 13, 1993
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